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ABSTRACT

This publication contains materials suitable for reproduction as transparencies or as classroom handouts. These metric materials may be used in a variety of occupational and practical arts courses. The format of the materials is in large print, some with humorous drawing; details of drawings and charts are easy to read. Introductory pages deal with all units of metric measures but the primary emphasis is upon linear uses of metric measures. Specific topics include: reading a metric micrometer and a vernier caliper, tables of metric hardware sizes, diagrams of metric hardware (nuts, bolts, screws, wrenches, etc.), master dimensioning, dual dimensioning, conversion tables, metric sizes of softwood, orthographic projection comparisons (first and third angle), paper sizes and weights, and printer's units. (JBW)

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# metrics in education

## RESOURCE MATERIALS

SE

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THE UNIVERSITY OF THE STATE OF NEW / THE STATE EDUCATION DEPARTMENT
Division of Curriculum Development/Albany, New York 12234

10mm=1cm 100cm=1m 1000m=1km

SE019964

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Director, Division of Occupational Education Instruction
Robert H. Bielefeld

# FOREWORD

The United States is going metric. Acceptance by business and industry as a necessity for world trade is accelerating the shift to metrics. All teachers in this State should be assessing their part in this change process. The Commissioner of Education has issued a policy statement endorsing metric instruction to prepare students to live in a metric world.

The metric system is really very simple. It is based on tens. Changing from one multiple or submultiple of a unit to another is accomplished by multiplying or dividing by ten. Changeover is presently on a voluntary basis, but is part of a worldwide trend. Over 90 percent of the world's population live in metric countries, or ones which are changing to metrics.

Three strategies are basic to instruction in metrics.

. The Need to Know

All people will need to know the basics of the metric system of measurement but not everyone will need to know all about metrics. Students will need only those terms and practices necessary to substitute for present measurement instruction. It is not necessary to memorize metric symbols, prefixes, base units, or derived units before the information is relevant to ongoing instruction.

. Metric First

The recommended format for writing measurements is to give the size, mass, or distance in correct metric terms followed by the customary measurement in brackets, if it is necessary. Thus twenty centimeters would be written 20 cm (7 7/8"). Using metric first will promote the concept of rounding off in metric just as we now do with customary measurements.

. Compare, Don't Convert

Compare or estimate distances, sizes, mass, or temperatures while learning the new system of measurement. Arithmetic conversions will not lead to facility with metrics.

In the belief that an immediate resource was needed, Arthur J. Dudley, Chief of the Bureau of Industrial Arts, initiated action resulting in this publication. These metric resources were compiled from materials developed by the Center for Metric Education, Western Michigan University. Selections were made by Jarvis Baillargeon, assisted by the staff of the Bureau of Industrial Arts. Robert H. Bielefeld, Director, Division of Occupational Education Instruction, recognized the use of these materials in a variety of occupational and practical arts courses.

These master sheets are being distributed to library media resource staff in each secondary and occupational school in the State for the local production of instructional handouts or overhead transparencies. Their use in schools will facilitate the preparation of learners to adequately handle the metric system in common measurements.

G. Earl Hay, *Supervisor*
*Bureau of Occupational and Career Curriculum Development*

Gordon E. Van Hooft, *Director*
*Division of Curriculum Development*

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This publication contains materials for the local production of transparencies or classroom instructional materials. It is a resource for lesson planning for metric instruction. The material is in the public domain and may be reproduced for classroom use.

# INTERNATIONAL SYSTEM OF UNITS (SI)

## Seven Base Units

1. Metre: Unit of length
2. Kilogram: Unit of mass
3. Second: Unit of time
4. Ampere: Unit of electric current
5. Celsius: Unit of temperature
6. Candela: Unit of luminous intensity
7. Mole: Unit of amount of substance



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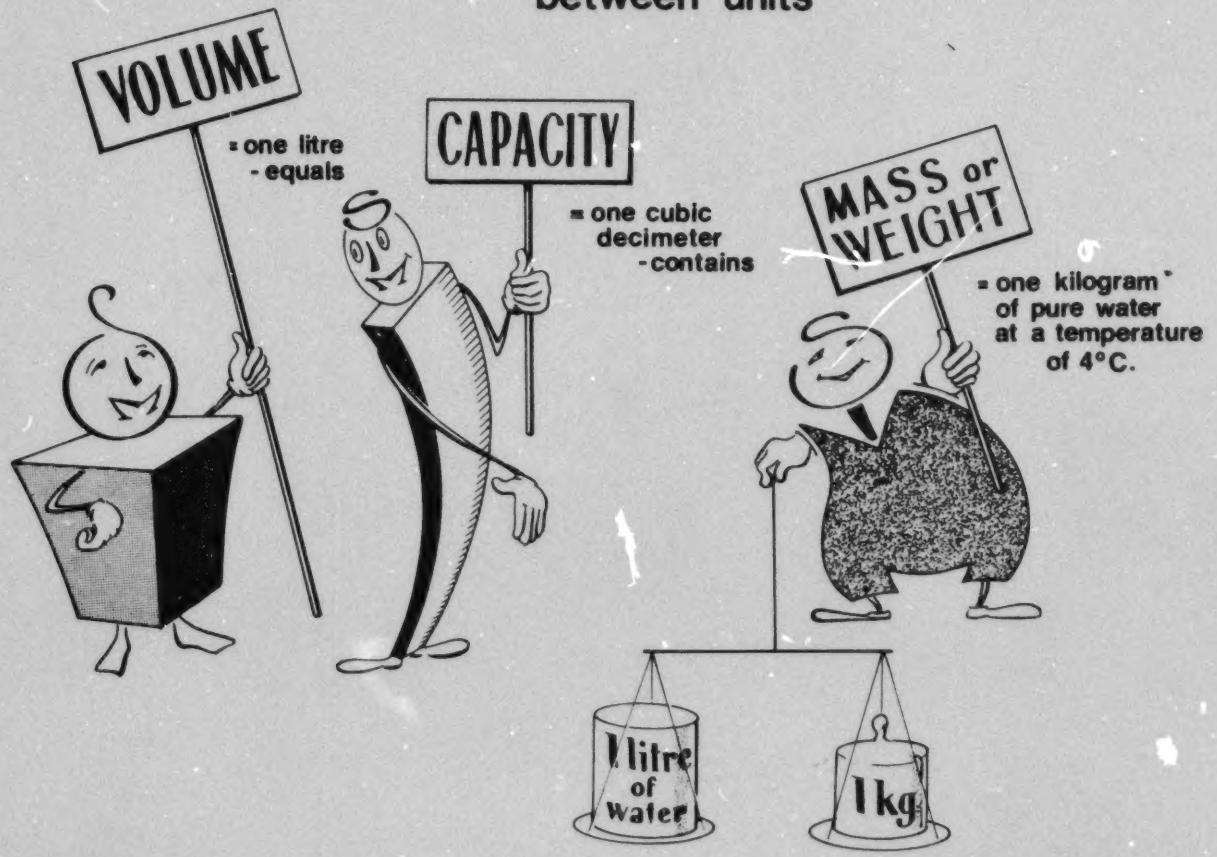
# In the metric system there is a definite relationship between units

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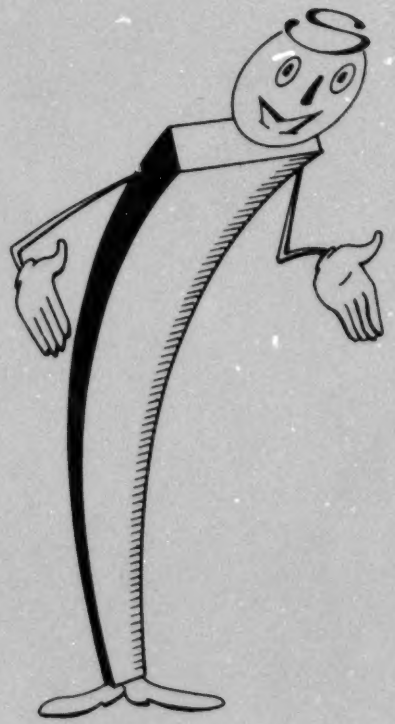
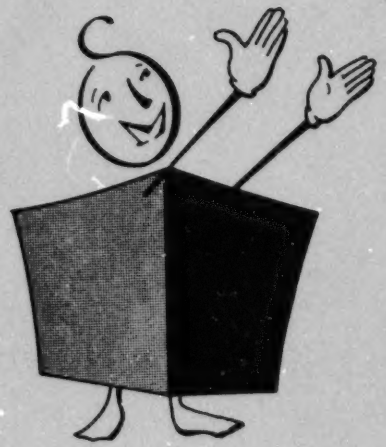
# THREE MEASUREMENTS to REMEMBER



THE **metre**
is a little longer
than a yard —
— 39.37 inches.



THE **litre**
is a little larger
than a quart
— about 6%

THE **kilogram**
is a little more
than twice the pound
— 2.2 pounds

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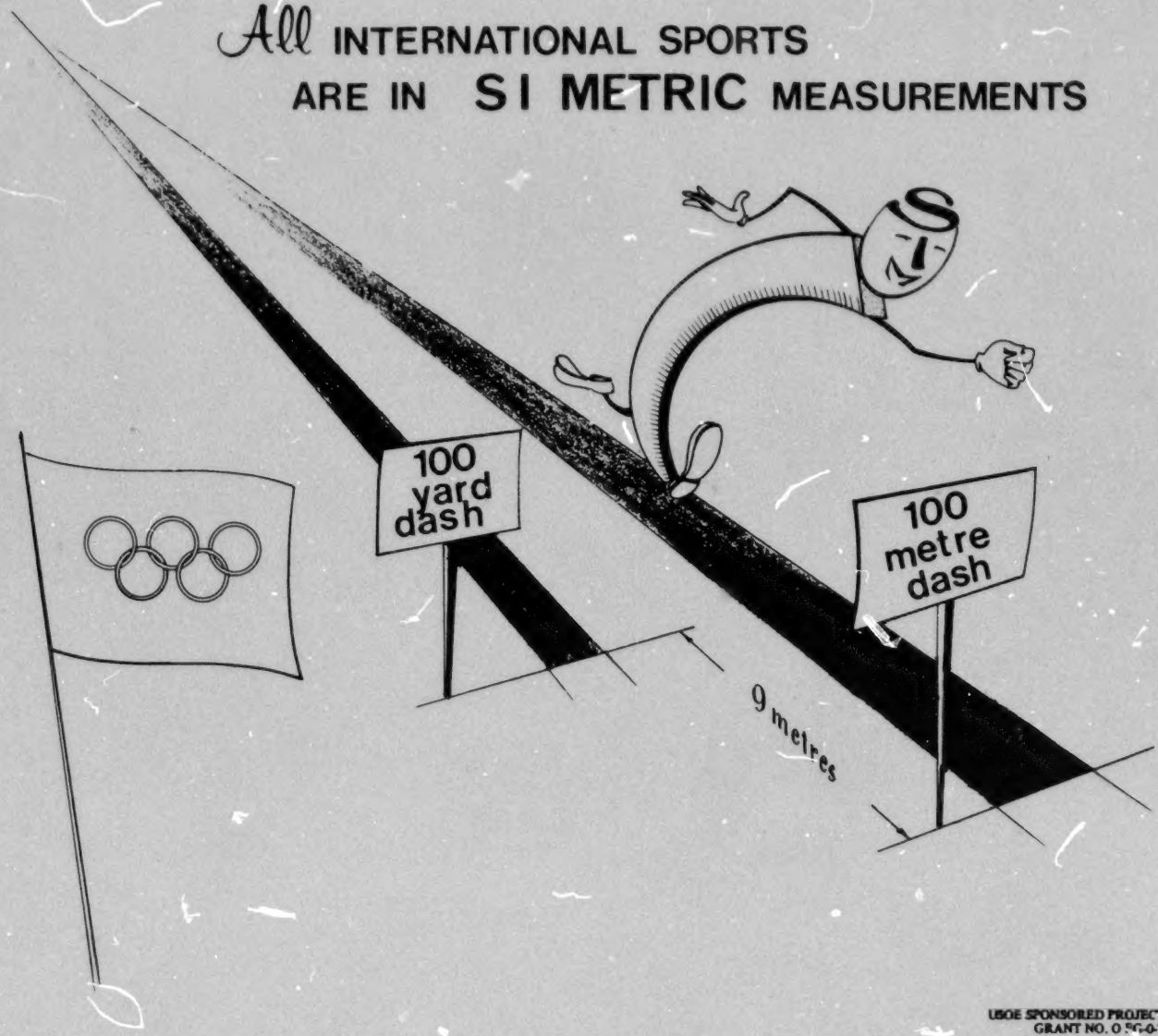
CENTER FOR METRIC EDUCATION • WESTERN MICHIGAN UNIVERSITY

# All INTERNATIONAL SPORTS ARE IN SI METRIC MEASUREMENTS

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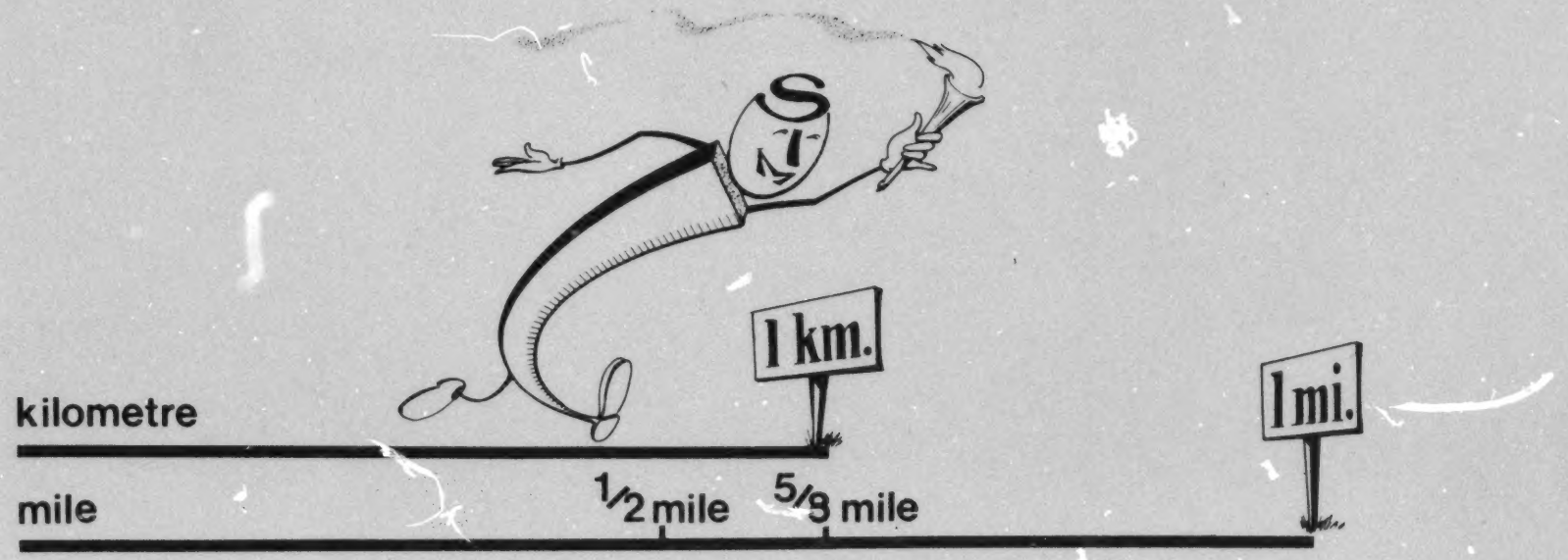
# A kilometre

- is used for long distances.

1000 metres equal one kilometre (km).

A kilometre is about 5/8 of a mile.



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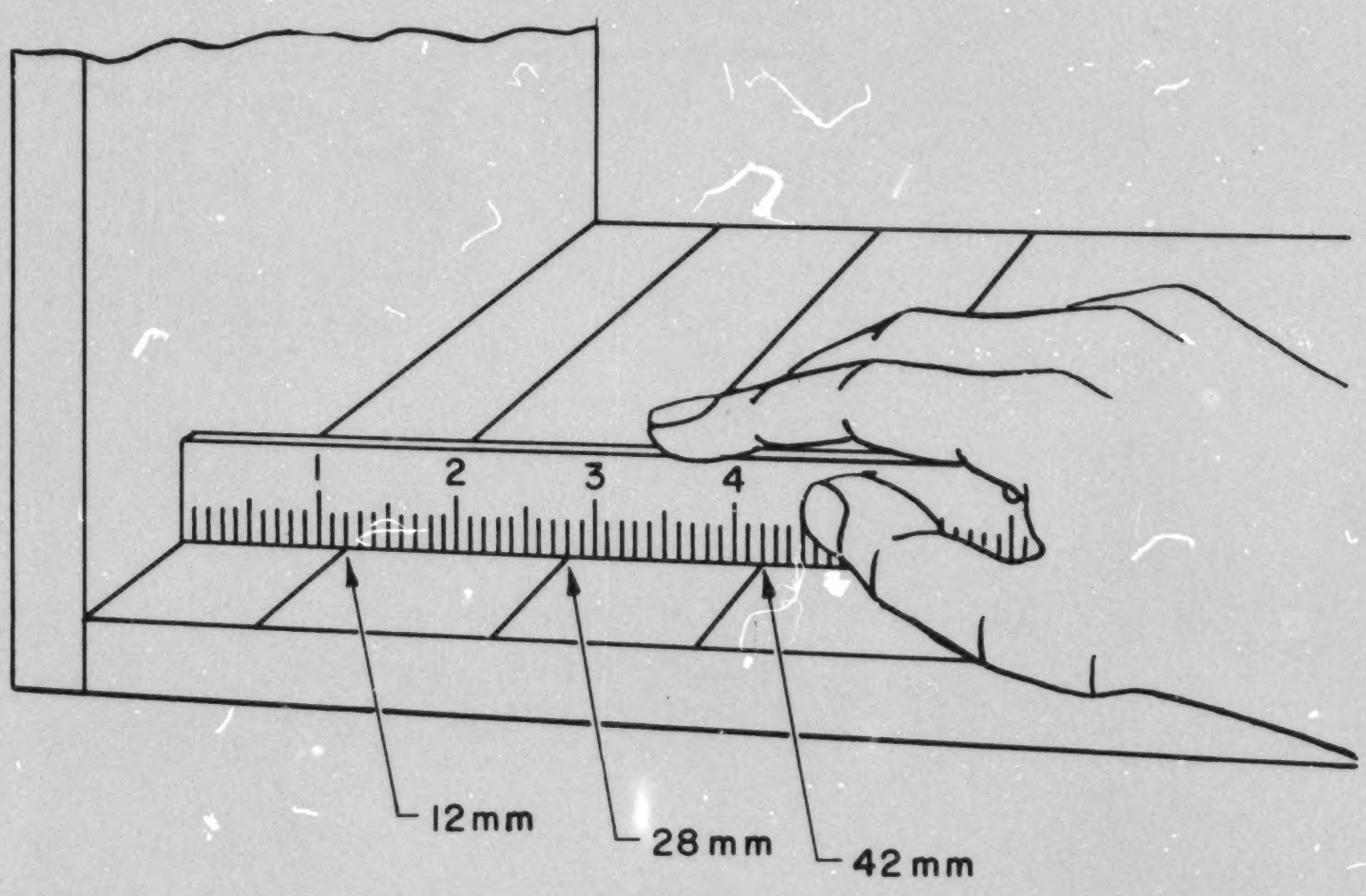


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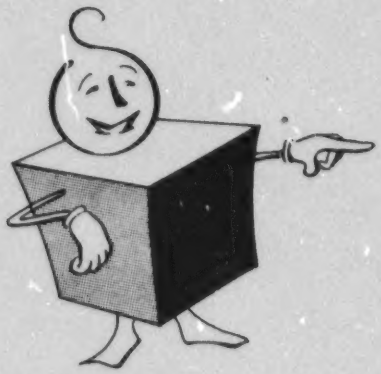
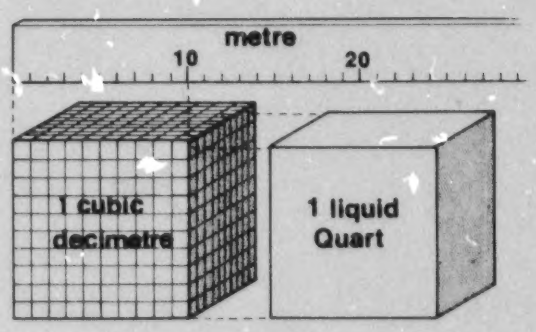
# Meet FIRST COUSIN Litre

## the derived unit of volume.

The litre is equal to one cubic decimetre (1 $dm^3$)
or 1 000 cubic centimetres (1 000 $cm^3$)
or 1 000 000 cubic millimetres (1 000 000 $mm^3$)
The litre is used for measuring liquids such as water, milk, paint, oil and many others.
The litre is slightly more (about 6%) than a quart.





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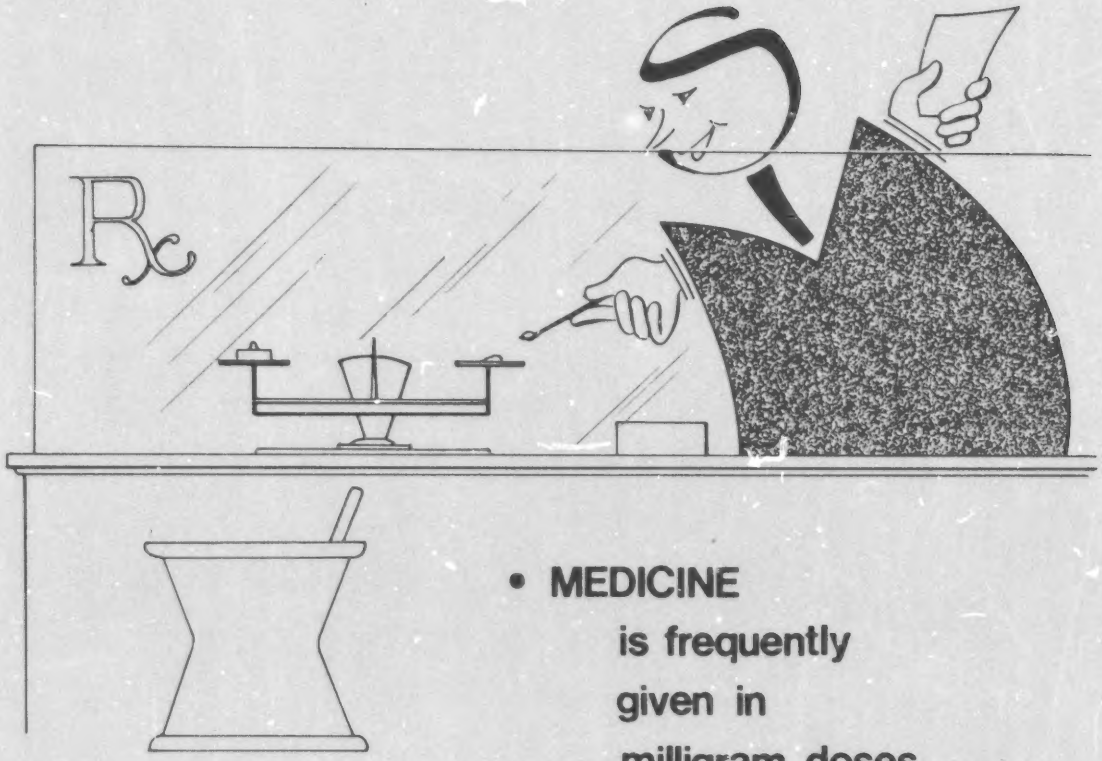
# For very small weights the milligram (mg) is used.
# 1 milligram = 0.001 gram




- MEDICINE is frequently given in milligram doses.



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# A NICKEL weighs about five grams

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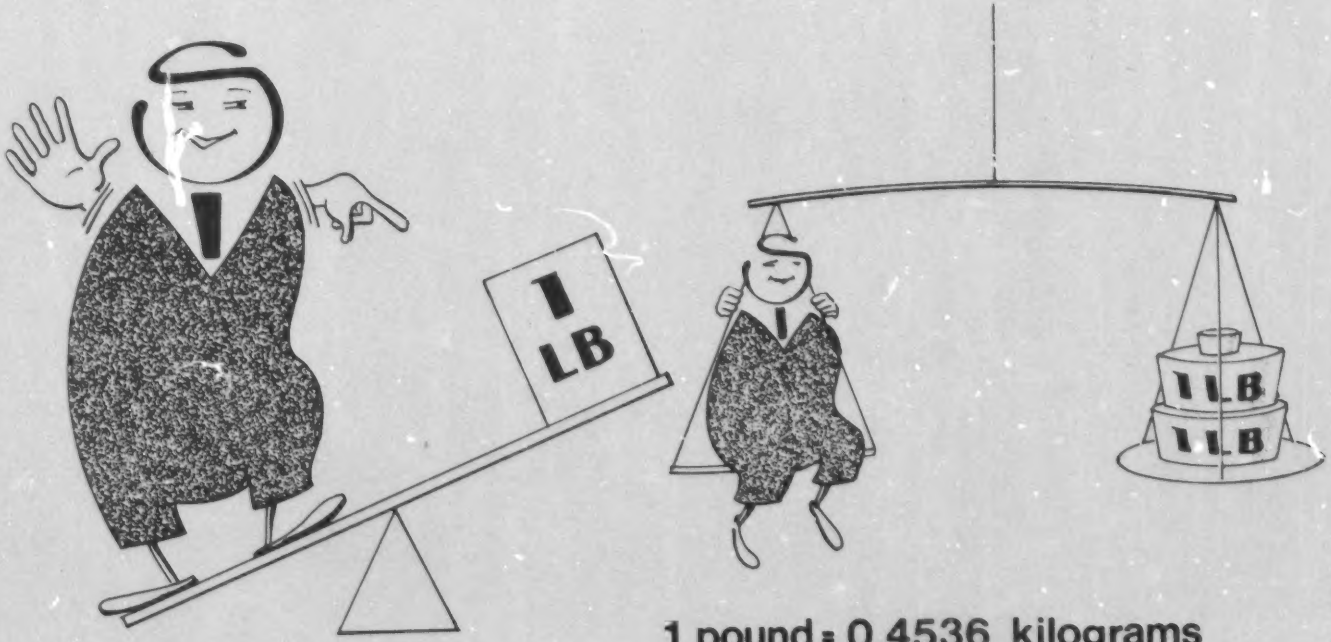
# I'M BROTHER KILOGRAM

I'm much heavier
than a pound!

I weight about
2.2 pounds.




1 pound = 0.4536 kilograms
1 kilogram = 2.2046 pounds



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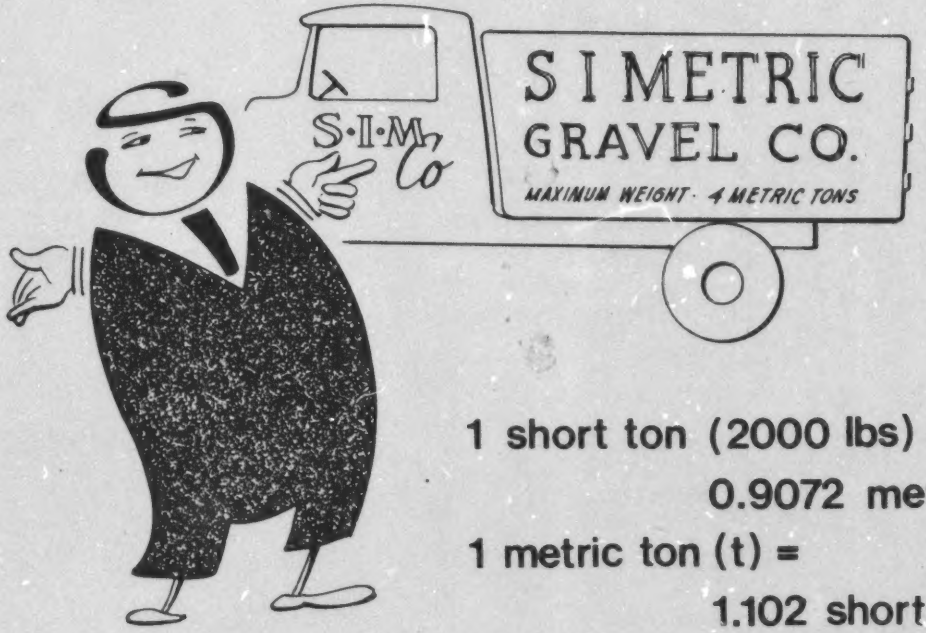
# For greater weights –
## the metric ton (t) is used.
## 1 metric ton = 1000 kilograms
## or about 2200 pounds




1 short ton (2000 lbs) =
0.9072 metric tons

1 metric ton (t) =
1.102 short tons

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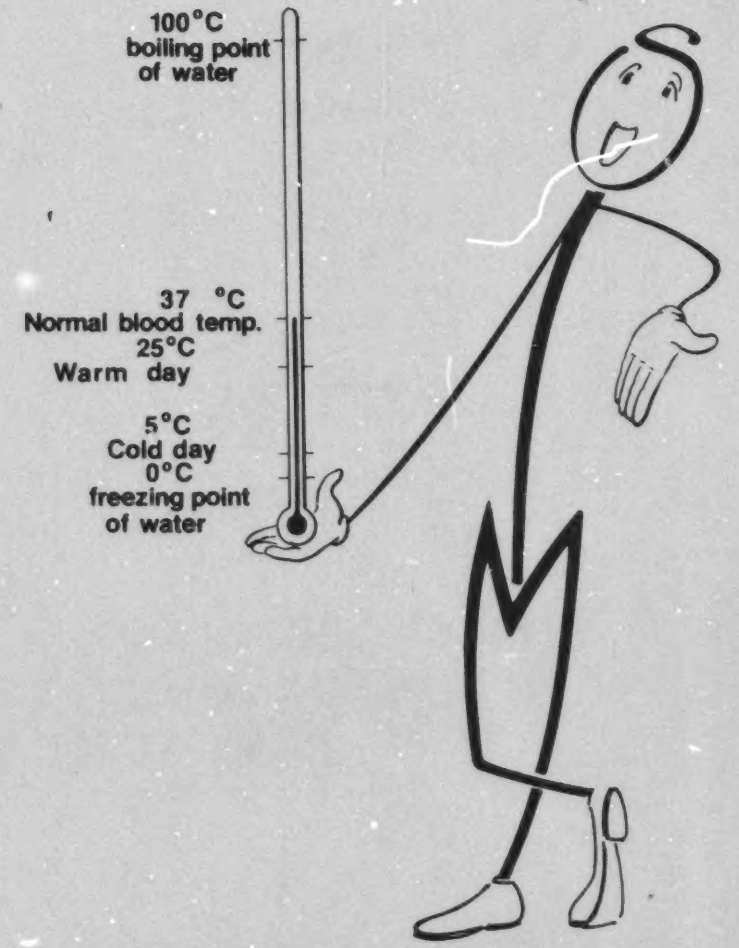
# SISTER Celsius

## TEMPERATURE

The common metric unit for TEMPERATURE is the degree Celsius. It is identical to the degree Centigrade.

The symbol is °C

Two common reference temperatures are
- 100 °C boiling point of water
- 0°C freezing point of water.



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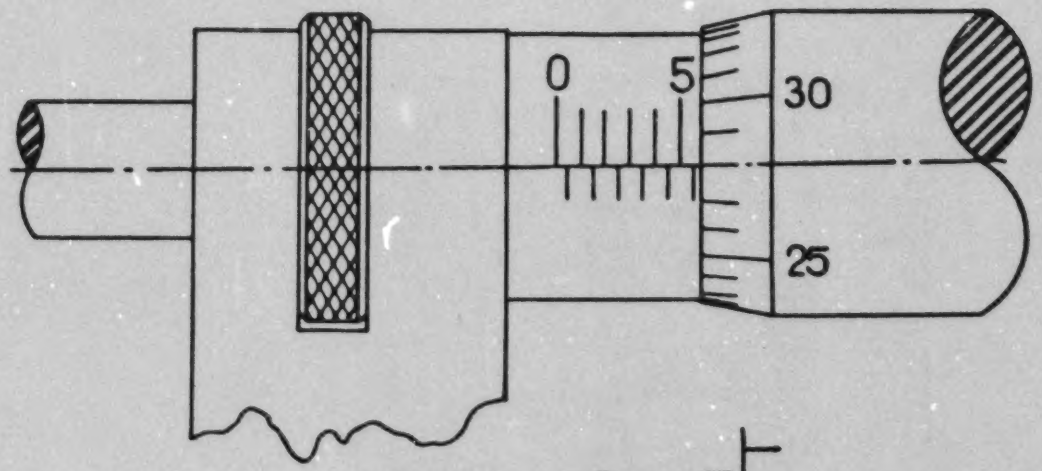
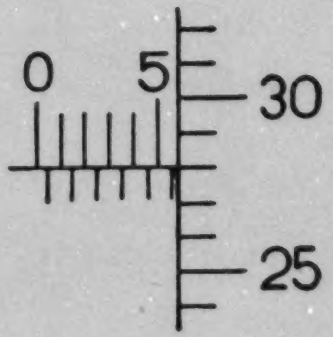
# READING A METRIC MICROMETER




SLEEVE THIMBLE

READING 5.78mm



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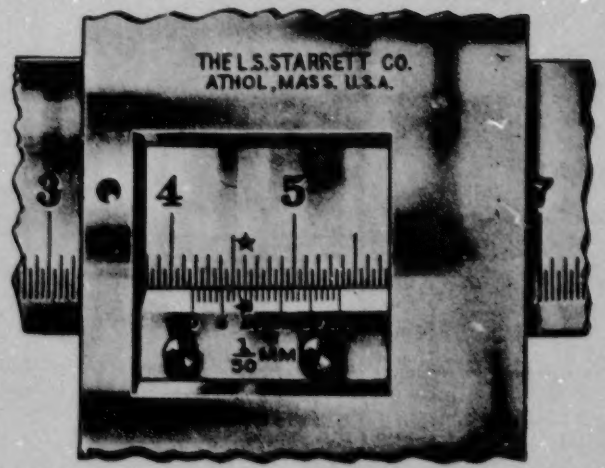
# METRIC VERNIER CALIPER




The correct reading is: 41.00 mm
0.50 mm
0.18 mm (9/50 mm)

Total 41.68 mm



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# ISO Metric Thread—Coarse Series

| Diameter ... ... ... | 2 | 2.5 | 3 | 4 | 5 | 6 | 8 | 10 |
|---|---|---|---|---|---|---|---|---|
| Pitch ... ... ... | 0.4 | 0.45 | 0.5 | 0.7 | 0.8 | 1.0 | 1.25 | 1.5 |
| Basic effective diameter ... | 1.740 | 2.208 | 2.675 | 3.545 | 4.480 | 5.350 | 7.188 | 9.026 |
| Depth of thread in screw | 0.25 | 0.28 | 0.31 | 0.43 | 0.49 | 0.61 | 0.77 | 0.92 |
| Area of Root dia. ($mm^2$) ... | 1.79 | 2.98 | 4.47 | 7.75 | 12.7 | 17.9 | 32.8 | 52.3 |
| Diameter of tapping drill | 1.6 | 2.05 | 2.5 | 3.3 | 4.2 | 5.0 | 6.8 | 8.5 |

| Diameter ... ... ... | 12 | 16 | 20 | 24 | 30 | 36 | 42 | 48 |
|---|---|---|---|---|---|---|---|---|
| Pitch ... ... ... | 1.75 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 |
| Basic effective diameter ... | 10.863 | 14.701 | 18.376 | 22.051 | 27.727 | 33.402 | 39.077 | 44.752 |
| Depth of thread in screw | 1.07 | 1.23 | 1.53 | 1.84 | 2.15 | 2.45 | 2.76 | 3.07 |
| Area of Root dia. ($mm^2$) ... | 76.2 | 144 | 225 | 324 | 519 | 759 | 1050 | 1380 |
| Diameter of tapping drill | 10.2 | 14.0 | 17.5 | 21.0 | 26.5 | 32.0 | 37.5 | 43.0 |



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## ISO Metric Thread—Fine Series

| Diameter ... ... ... | 8 | 10 | 12 | 14 | 16 | 18 | 20 |
|---|---|---|---|---|---|---|---|
| Pitch ... ... ... | 1.0 | 1.25 | 1.25 | 1.5 | 1.5 | 1.5 | 1.5 |
| Basic effective dia. ... | 7.350 | 9.188 | 11.188 | 13.026 | 15.026 | 17.026 | 19.026 |
| Depth of thread in screw | 0.61 | 0.77 | 0.77 | 0.92 | 0.92 | 0.92 | 0.92 |
| Area of Root dia. ($mm^2$) ... | 36.0 | 56.3 | 86.0 | 116 | 157 | 205 | 259 |
| Diameter of tapping drill | 7.0 | 8.8 | 10.8 | 12.5 | 14.5 | 16.5 | 18.5 |

| Diameter ... ... ... | 22 | 24 | 30 | 36 | 42 | 48 |
|---|---|---|---|---|---|---|
| Pitch ... ... ... | 1.5 | 2.0 | 2.0 | 3.0 | 3.0 | 3.0 |
| Basic effective diameter ... | 21.026 | 22.701 | 28.701 | 34.051 | 40.051 | 46.051 |
| Depth of thread in screw | 0.92 | 1.23 | 1.23 | 1.84 | 1.84 | 1.84 |
| Area of Root dia. ($mm^2$) ... | 319 | 365 | 586 | 820 | 1210 | 1540 |
| Diameter of tapping drill | 20.5 | 22.0 | 28.0 | 33.0 | 39.0 | 45.0 |



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# COMPARISON OF COMMON THREAD SIZES

## ISO METRIC THREAD

COARSE THREAD SERIES

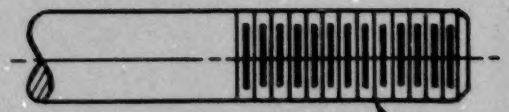
M10 x 1.5 - 6g

- THREAD SYMBOL FOR ISO
- NOMINAL SIZE IN MILLIMETRES
- PITCH IN MILLIMETRES
- THREAD TOLERANCE CLASS SYMBOL

| ISO METRIC | UNIFIED NATIONAL |
|---|---|
| 24 x 3 | 1-8 |
| | 7/8-9 |
| 20 x 2.5 | 3/4-10 |
| 16 x 2 | 5/8-11 |
| | 9/16-12 |
| 12 x 1.75 | 1/2-13 |
| | 7/16-14 |
| 10 x 1.5 | 3/8-16 |
| 8 x 1.25 | 5/16-18 |
| | 1/4-20 |
| 6 x 1 | 12-24 |
| 5 x .8 | 10-24 |
| 4 x .7 | 8-32 |
| | 6-32 |
| 3 x .5 | 5-40 |
| | 4-40 |
| 2.5 x .45 | 3-48 |
| | 2-56 |
| 2 x .4 | |

## UNIFIED NATIONAL

COARSE THREAD SERIES



$\frac{3}{8}$ - 16 UNC - 2A

- MAJOR DIA
- THREADS PER INCH
- THREAD SERIES
- CLASS

NOTE -
THE METRIC THREAD ILLUSTRATED IS A LITTLE LARGER IN DIAMETER THAN 3/8" AND HAS ALMOST 17 THREADS PER INCH.

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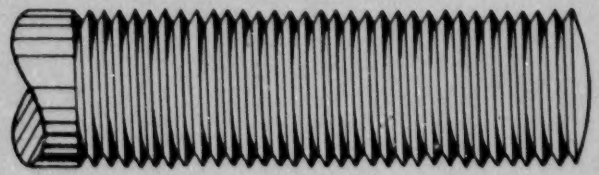
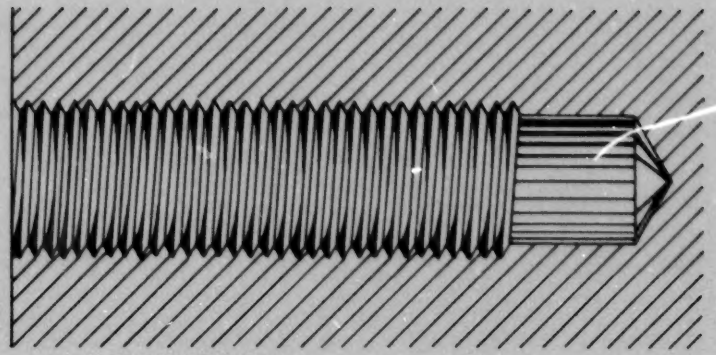
# THREADS :

## EXTERNAL



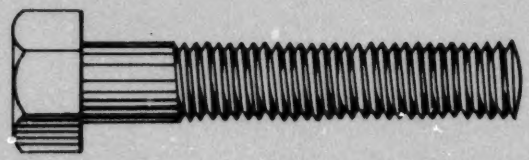
M12 X 1.75 — 6g

## INTERNAL



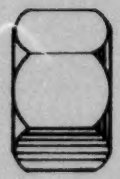
M12 X 1.75 — 6H

## SCREWS & BOLTS



M12 — 6g

## NUTS



M12 — 6H

| CLASS OF FIT | TOLERANCE CLASS | |
|---|---|---|
| | Bolts & Screws | Nuts |
| Medium | 6g | 6H |



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# ISO METRIC THREAD FORM

$P$ = PITCH in mm

$H = 0.86603P$

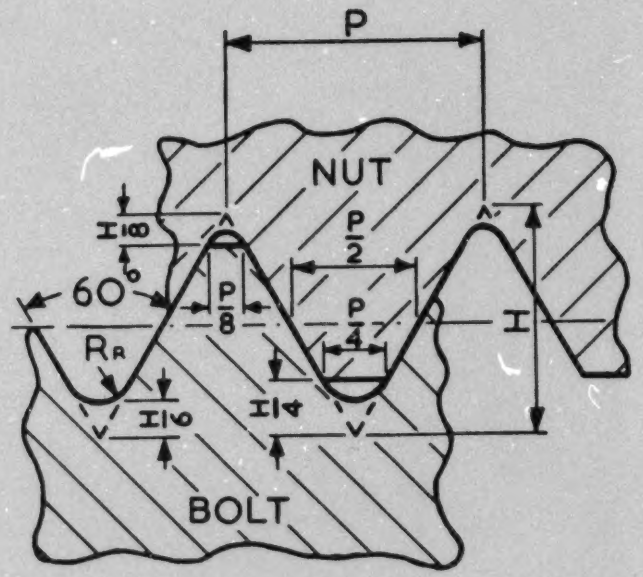
$\frac{H}{4} = 0.21651P$

$\frac{H}{6} = 0.14434P$ $\quad \frac{H}{8} = 0.10825P$

$R_R = 0.14434P$

Depth of thread in screw $= \frac{17}{24} H = 0.61343P$

Depth of thread in nut $= \frac{5}{8} H = 0.54127P$



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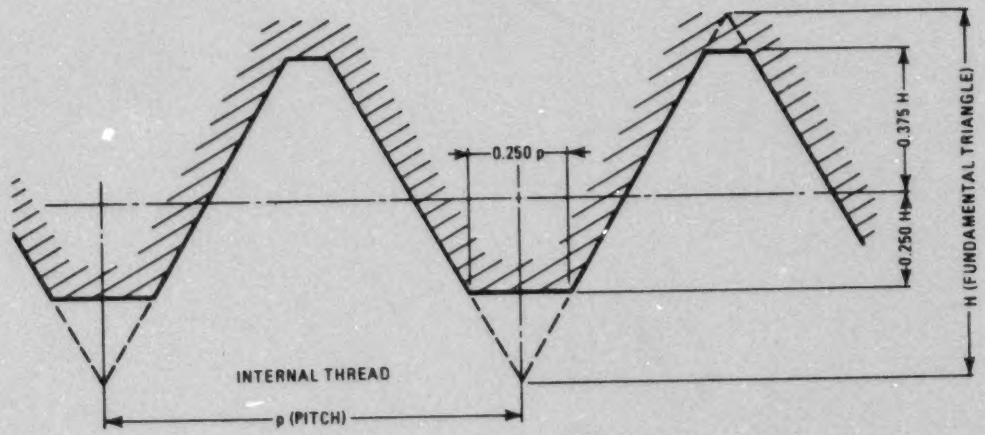
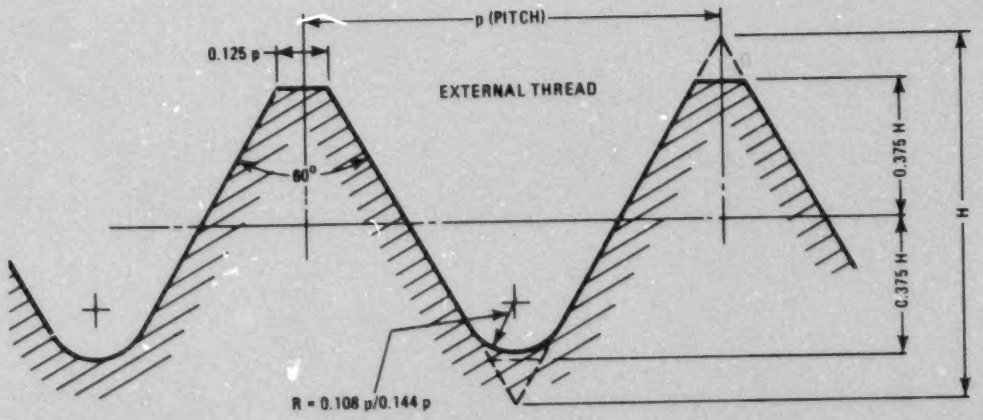
## THREAD FORM – ISO METRIC AND ISO INCH SERIES

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GRANT NO. O EG-0-72-1868

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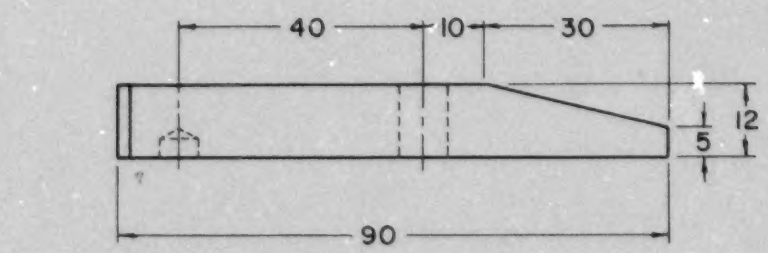
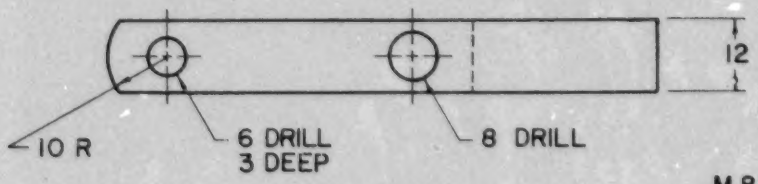
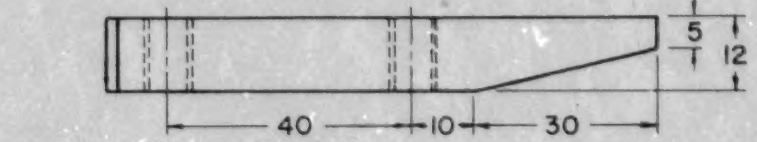
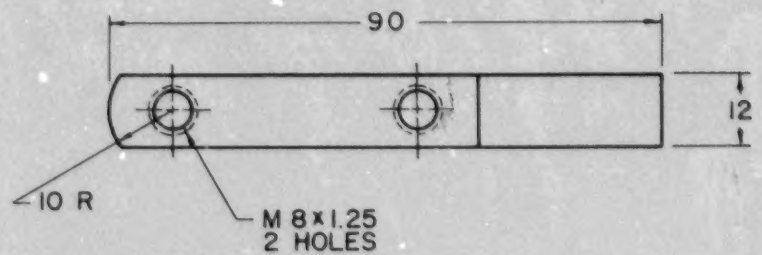
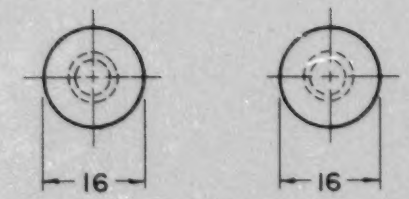
# METRIC DRAWING - METALWORKING
# (TOOLMAKER'S CLAMP)

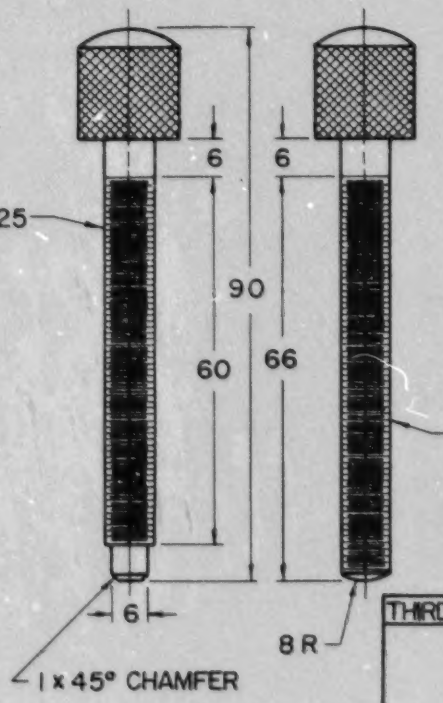


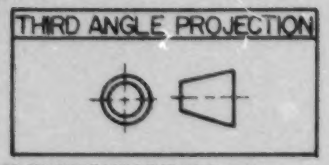




| CONVERSION CHART | |
|---|---|
| mm | inch |
| 1 | 0.039 |
| 3 | 0.118 |
| 5 | 0.197 |
| 6 | 0.236 |
| 8 | 0.315 |
| 10 | 0.394 |
| 12 | 0.472 |
| 16 | 0.630 |
| 30 | 1.181 |
| 40 | 1.575 |
| 60 | 2.362 |
| 66 | 2.598 |
| 90 | 3.543 |

ISO METRIC THREAD
M 8 x 1.25

UNC THREAD
5/16-18-UNC

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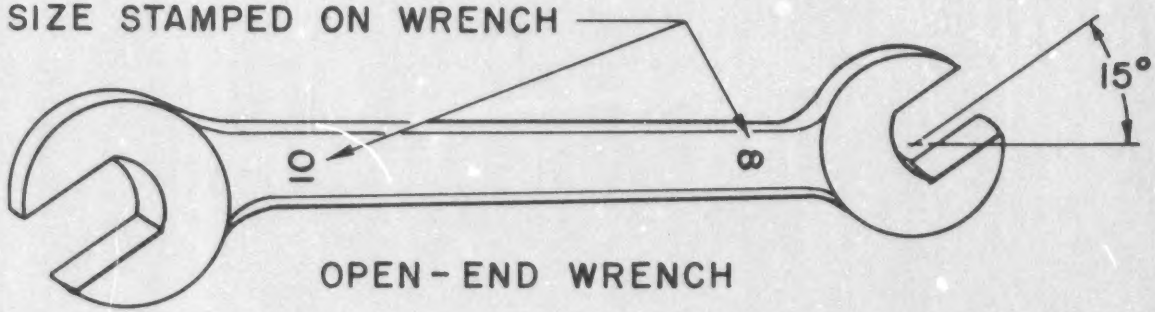
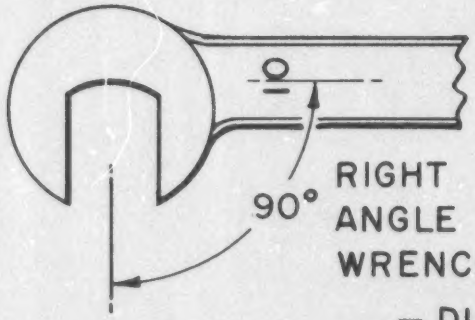
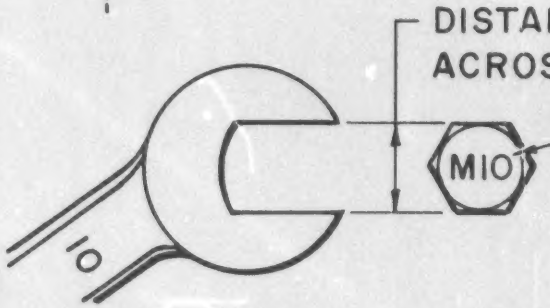



OPEN-END WRENCH

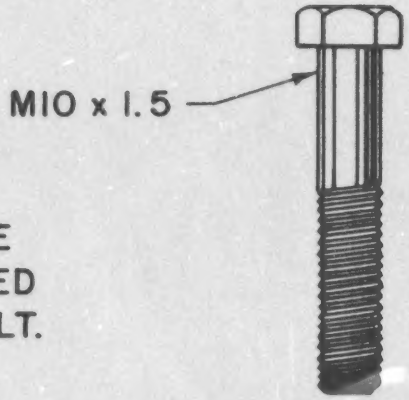
M10 METRIC WRENCH FOR M10 BOLT. ( DO NOT CONFUSE WITH INCH SIZE WRENCHES. 10 mm IS BETWEEN A 3/8" AND 7/16" WRENCH IN SIZE.)




RIGHT ANGLE WRENCH




SOMETIMES SIZE "M10" IS STAMPED ON HEAD OF BOLT.



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## Temperatures, Steel Colors, and Related Processes

| | Colors | F | °C | Processes |
|---|---|---|---|---|
| Heat Colors | White | 2500° | 1371° | Welding |
| | | 2400° | 1315° | |
| | Yellow-White | 2300° | 1259° | High speed steel hardening (1177-1343°C) |
| | | 2200° | 1204° | |
| | | 2100° | 1149° | |
| | Yellow | 2000° | 1093° | |
| | | 1900° | 1036° | |
| | Orange-Red | 1800° | 981° | |
| | | 1700° | 926° | |
| | | | | Alloy tool steel hardening (816-1066°C) |
| | | 1600° | 871° | |
| | Light cherry red | 1500° | 815° | |
| | | | | Carbon tool steel hardening (732-843°C) |
| | Cherry red | 1400° | 760° | |
| | | 1300° | 704° | |
| | Dark red | | | |
| | | 1200° | 648° | |
| | | 1100° | 593° | |
| | | | | High speed steel tempering (538-593°C) |
| | | 1000° | 538° | |
| | Very dark red | | | |
| | | 900° | 482° | |
| | | 800° | 426° | |
| | Black red in dull light or darkness | 700° | 371° | |
| | | | | Carbon tool steel tempering (149-566°C) |
| Temper Colors | Pale blue (310°C) | 600° | 315° | |
| | Violet (285°C) | | | |
| | Purple (274°C) | 500° | 260° | |
| | Yellowish-Brown (254°C) | 400° | 204° | |
| | Dark straw (241°C) | | | |
| | | 300° | 149° | |
| | Light straw (218°C) | | | |
| | | 200° | 93° | |
| | | 100° | 38° | |
| | | 0° | 18° | |

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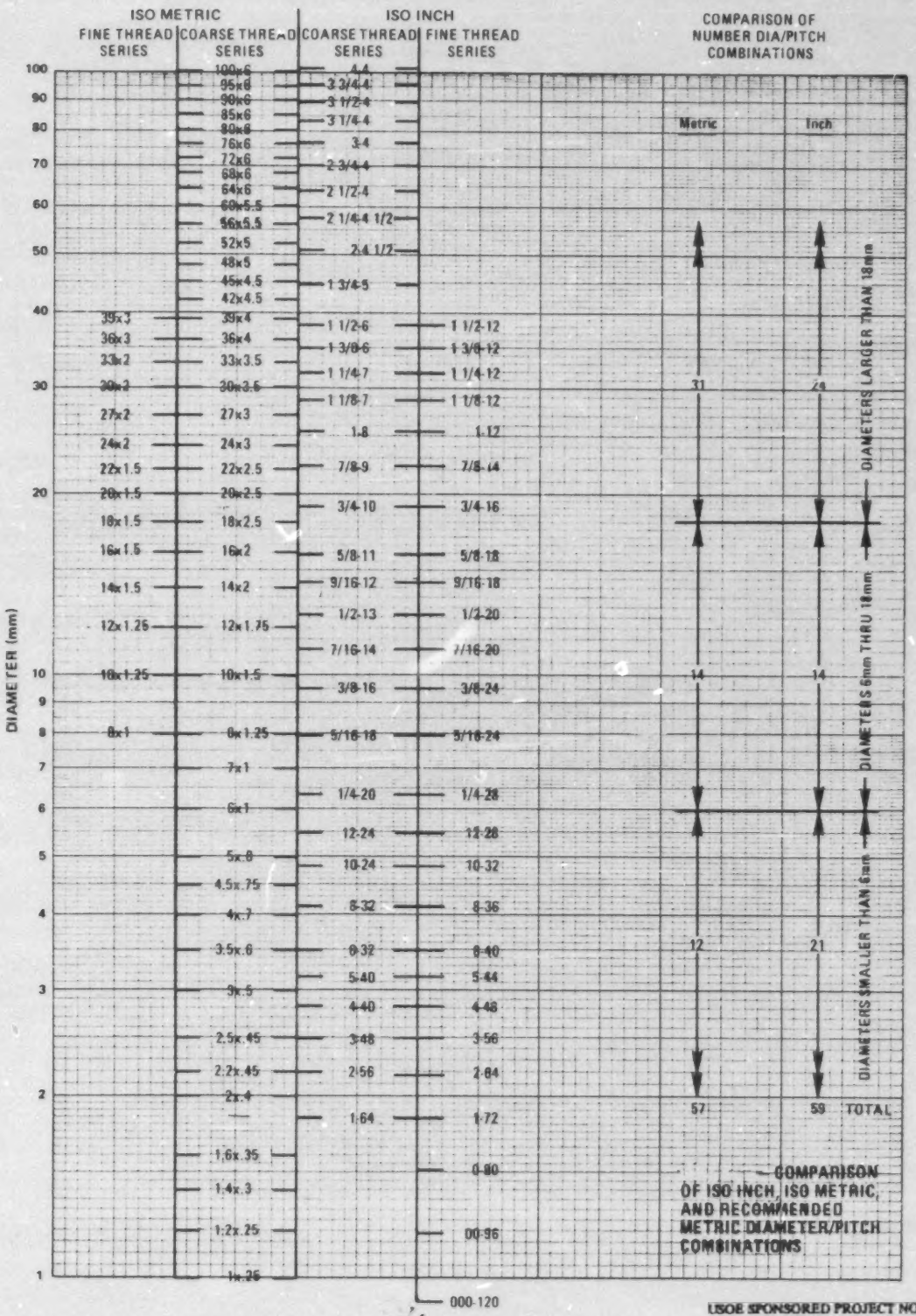


USOE SPONSORED PROJECT NO. V257006
GRANT NO. O EG-0-72-1868

PROBABLE BASIC METRIC SIZES OF SOFTWOOD LUMBER SURFACED FOUR SIDES - U.S.A.

The following chart shows a close approximation to probable American lumber sizes. This chart is designed to show how we might proceed with our lumber conversions in this country; that is, by converting to the nearest millimetre equivalent. For example, in the .75" or 3/4" standard, we might adopt a 19 mm size. It would be hoped, however, that we would have the good sense to round these off to the nearest millimetre in order to make them more easy with which to work. For example, a piece of half inch lumber might become 15 mm instead of 13 and a piece of 3/4" lumber might become 20 instead of 19, slightly larger in each case. Note that the same thing holds true with the metric length equivalent. We may have to retain direct metric equivalents for customary sizes for repair and modeling reasons. For example, we may have to continue to make sheets of plywood 1.22 m by 2.44 m which is, of course, the metric equivalent for the 4' x 8' sheets of plywood. The reason for this continuance would be to accommodate stud placement in a wall section. When it comes to determining the lengths for lumber, we will probably select a 1.80 m length to approximate 6'; a 2.40 m length to approximate 8'; 3.00 m for 10'; 3.60 m for 12'; 4.2 m for 14'; 4.8 m for 16'; 5.4 m for 18'; and 6.1 m for 20'. Because there is no movement in the United States to determine metric lumber sizes, the chart should be considered for study and discussion purposes only.

# Probable Basic Metric Sizes of Softwood Lumber Surfaced Four Sides U.S.A.

| Thickness | | Width in mm | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Approx. Inches | mm | 50 | 75 | 100 | 150 | 200 | 250 | 300 |
| .5 | 13 | x | x | x | x | x | x | x |
| .75 | 19 | x | x | x | x | x | x | x |
| 1 | .25 | x | x | x | x | x | x | x |
| 1.5 | 38 | x | | x | x | x | x | x |
| 2 | 50 | x | | x | x | x | x | x |
| 4 | 100 | x | | x | x | x | x | x |
| 6 | 150 | x | | x | x | x | x | x |
| 8 | 200 | x | | x | x | x | x | x |
| 10 | 250 | x | | x | x | x | x | x |
| 12 | 300 | x | | x | x | x | x | x |

Length: 1.83 m (6') 2.44 m (8') 3.05 m (10') 3.66 m (12')
4.27 m (14') 4.88 m (16') 5.49 m (18') 6.10 m (20')

Probable 4' x 8' Panel Size: 1220 mm x 2440 mm, or
1.22 m x 2.44 m

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# BORING CHART FOR WOOD SCREWS

Customary and Metric Sizes

| No. of Screw | Max. Head Dia. Inch | SHANK DIAMETER | | | ROOT DIAMETER | | | Thread per Inch | No. of Screw |
|---|---|---|---|---|---|---|---|---|---|
| | | Basic Dec. Size Inch | Nearest Drill Equivalent Inch | mm | Average Dec. Size Inch | Nearest Drill Equivalent Inch | mm | | |
| 0 | .119 | .060 | 1/16 | 1.5 | .040 | 3/64 | 1.0 | 32 | 0 |
| 1 | .146 | .073 | 5/64 | 2.0 | .046 | 3/64 | 1.0 | 28 | 1 |
| 2 | .172 | .086 | 3/32 | 2.5 | .054 | 1/16 | 1.5 | 26 | 2 |
| 3 | .199 | .099 | 7/64 | 3.0 | .065 | 1/16 | 1.5 | 24 | 3 |
| 4 | .225 | .112 | 7/64 | 3.0 | .075 | 5/64 | 2.0 | 22 | 4 |
| 5 | .252 | .125 | 1/8 | 3.5 | .085 | 5/64 | 2.0 | 20 | 5 |
| 6 | .279 | .138 | 9/64 | 3.5 | .094 | 3/32 | 2.5 | 18 | 6 |
| 7 | .305 | .151 | 5/32 | 4.0 | .102 | 7/64 | 2.5 | 16 | 7 |
| 8 | .332 | .164 | 5/32 | 4.0 | .112 | 7/64 | 2.5 | 15 | 8 |
| 9 | .358 | .177 | 11/64 | 4.5 | .122 | 1/8 | 3.0 | 14 | 9 |
| 10 | .385 | .190 | 3/16 | 5.0 | .130 | 1/8 | 3.0 | 13 | 10 |
| 11 | .411 | .203 | 13/64 | 5.5 | .139 | 9/64 | 3.5 | 12 | 11 |
| 12 | .438 | .216 | 7/32 | 5.5 | .148 | 9/64 | 3.5 | 11 | 12 |
| 14 | .491 | .242 | 1/4 | 6.5 | .165 | 5/32 | 4.0 | 10 | 14 |
| 16 | .544 | .268 | 17/64 | 7.0 | .184 | 3/16 | 4.5 | 9 | 16 |
| 18 | .597 | .294 | 19/64 | 7.5 | .204 | 13/64 | 5.0 | 8 | 18 |
| 20 | .650 | .320 | 5/16 | 8.0 | .223 | 7/32 | 5.5 | 8 | 20 |
| 24 | .756 | .372 | 3/8 | 9.5 | .260 | 1/4 | 6.0 | 7 | 24 |

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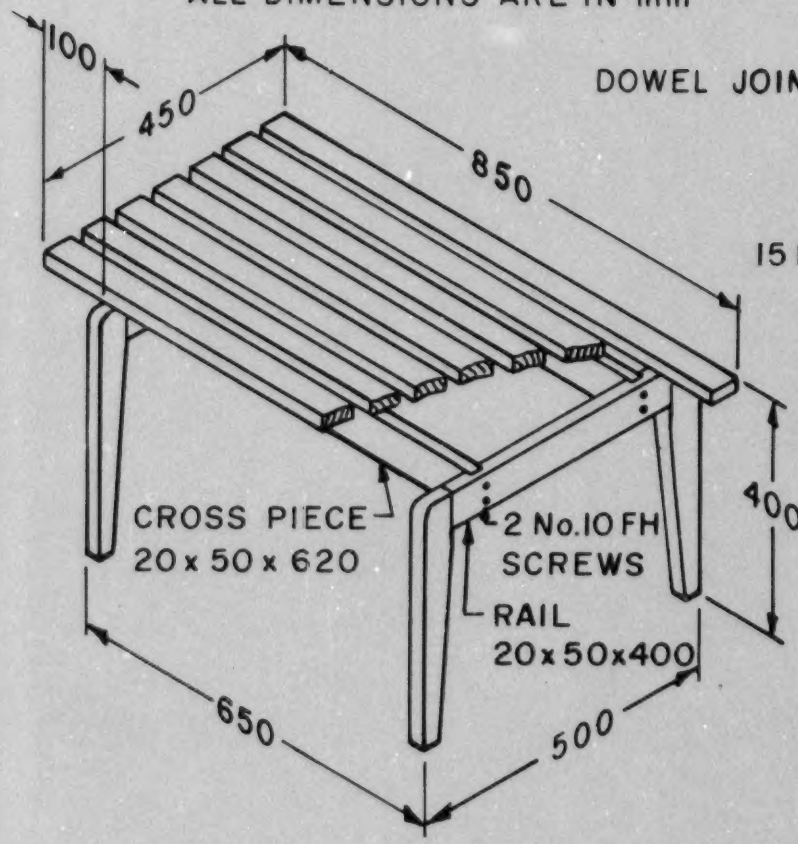
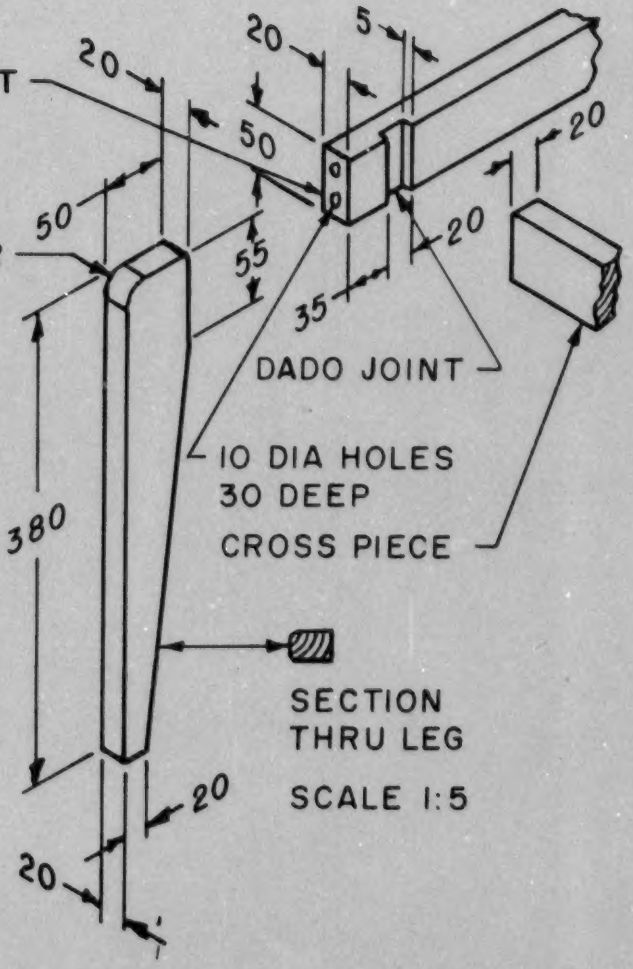
# PATIO TABLE

MATERIAL - PINE

ALL DIMENSIONS ARE IN mm




SCALE 1:10




SECTION
THRU LEG

SCALE 1:5

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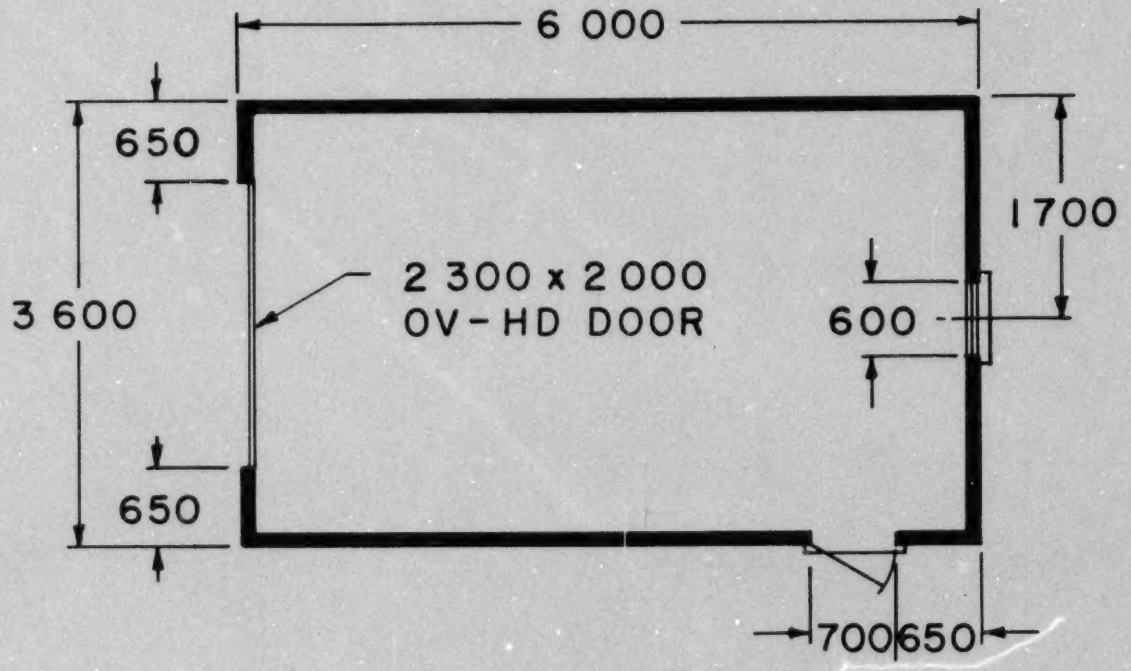
F633

# SMALL CAR GARAGE

ALL DIMENSIONS IN mm
SCALE: 1:50




E.634

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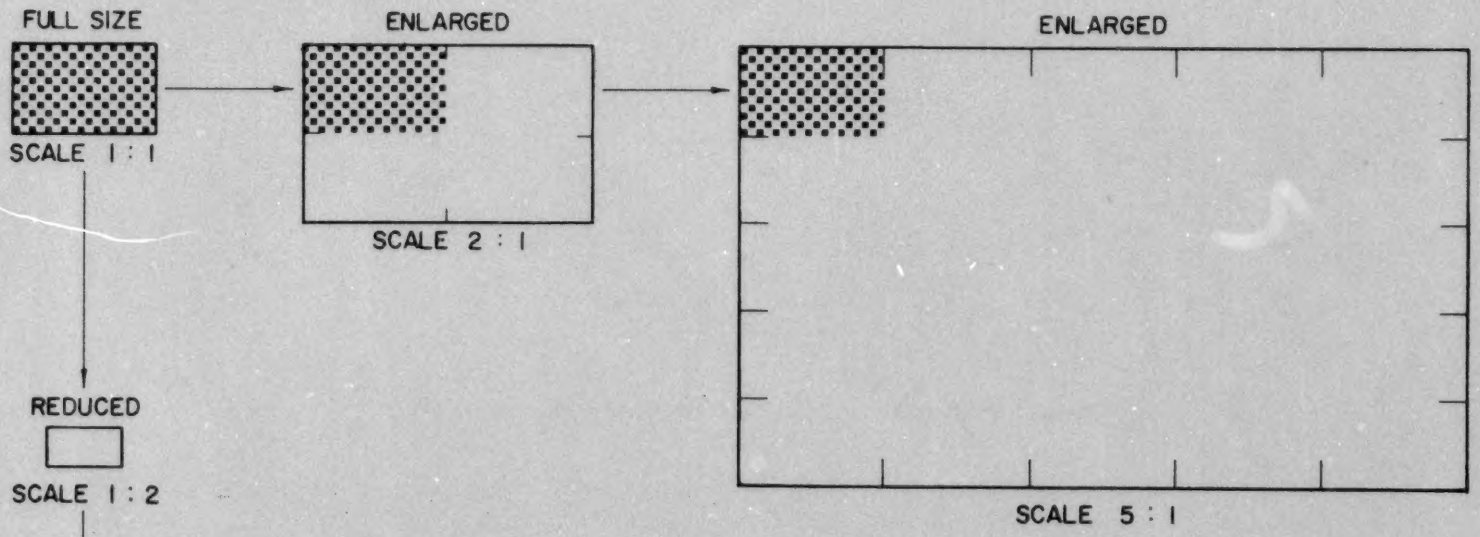
# ENLARGEMENT AND REDUCTION SCALES




| THE USUAL METRIC SCALES ARE : | | | | | |
|---|---|---|---|---|---|
| FULL SIZE | 1 : 1 | | | | |
| ENLARGEMENT | 2 : 1 | 5 : 1 | 10 : 1 | 20 : 1 | 50 : 1 |
| REDUCTION | 1 : 2 | 1 : 5 | 1 : 10 | 1 : 20 | 1 : 50 |

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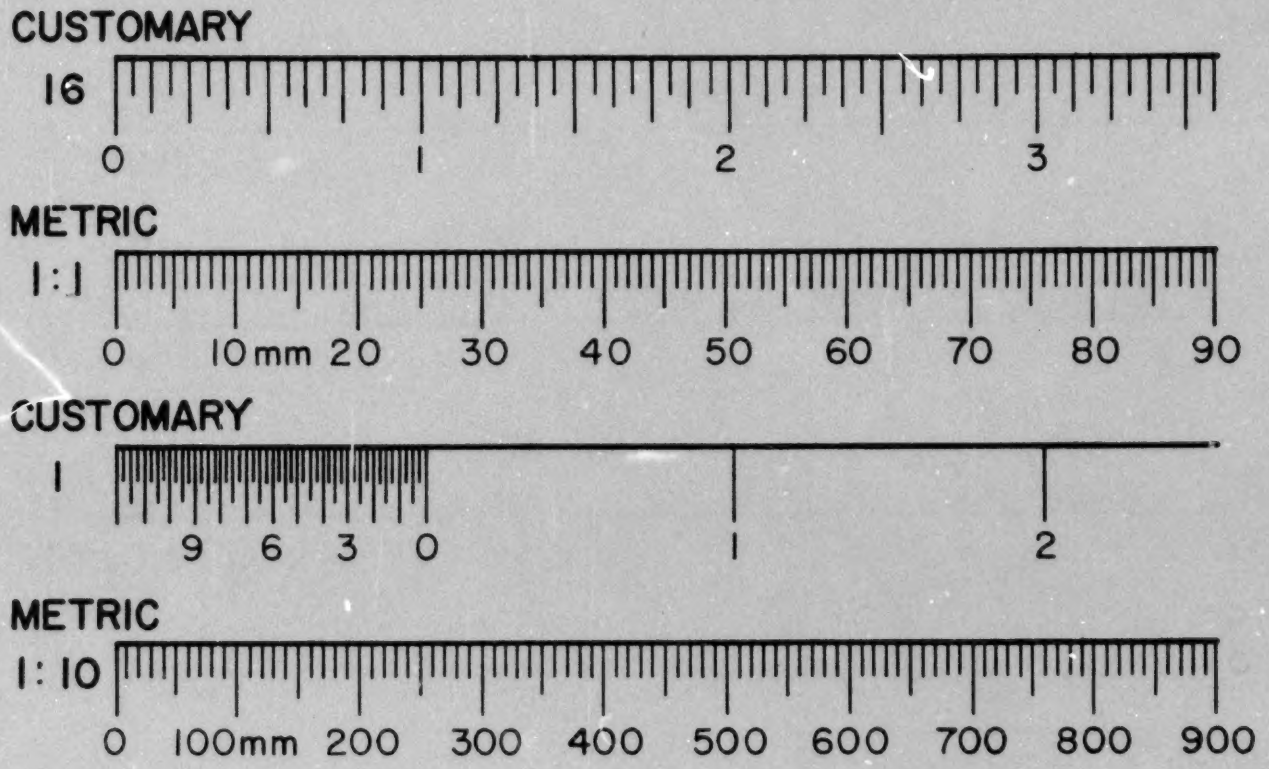
# ARCHITECTS SCALE COMPARISON



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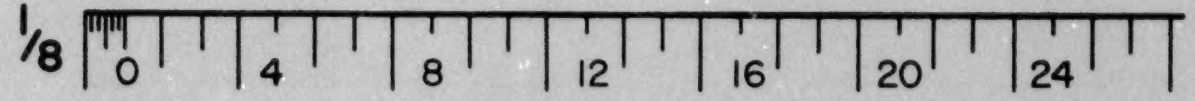
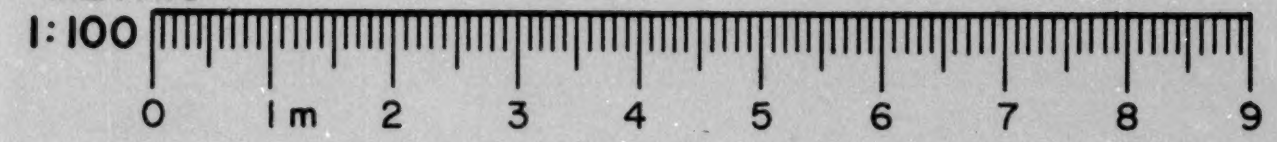
# ARCHITECTS SCALE COMPARISON

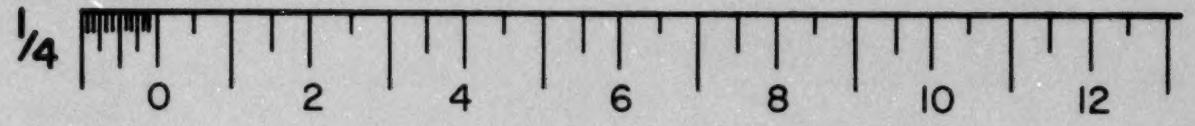
**CUSTOMARY**



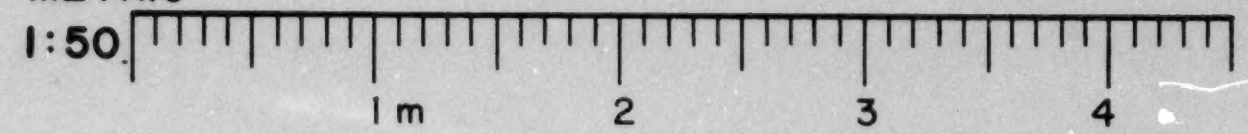

**METRIC**




**CUSTOMARY**




**METRIC**

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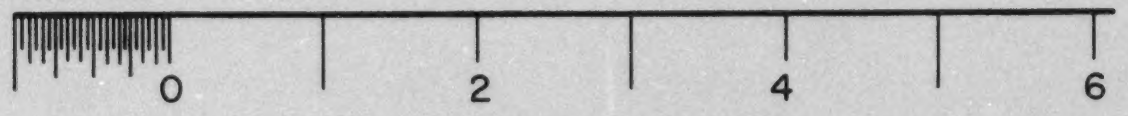
# ARCHITECTS SCALE COMPARISON

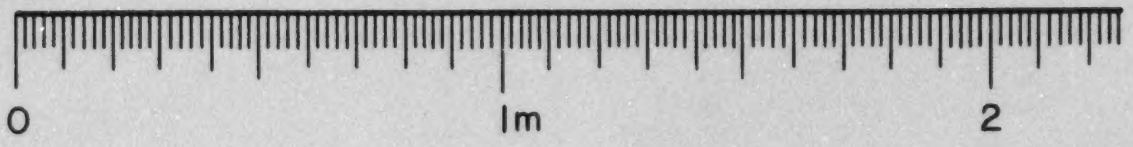
CUSTOMARY

1/2




METRIC

1 : 25




ADDITIONAL COMMON METRIC SCALES

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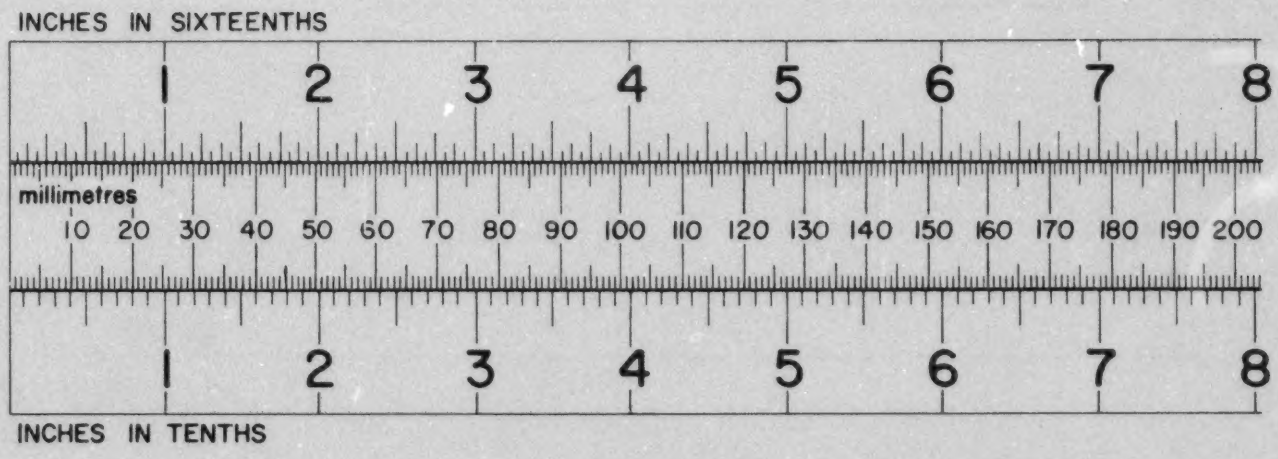
# DIRECT READING CONVERSION SCALE

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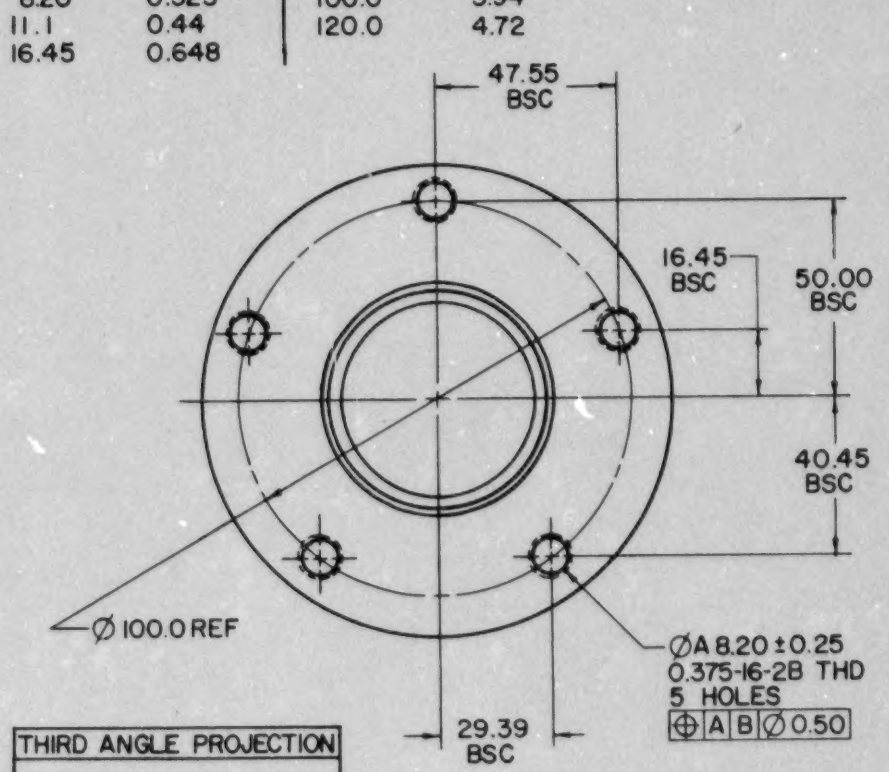
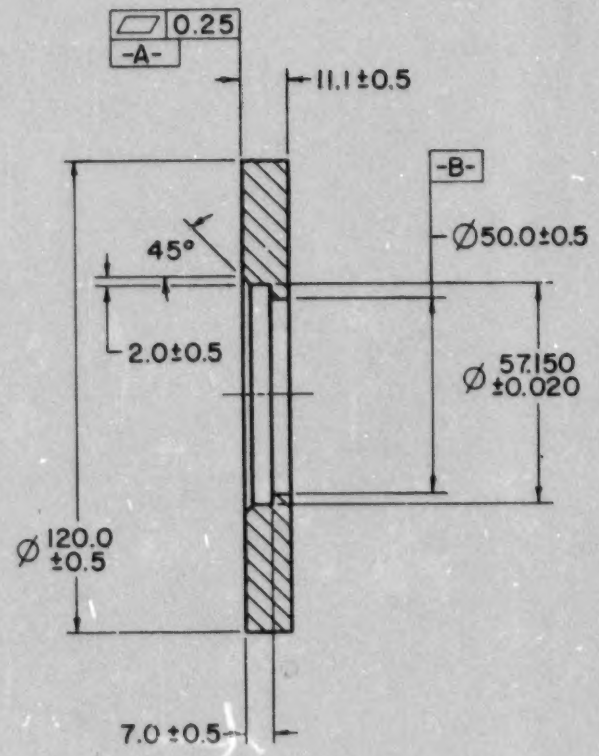
# MASTER DIMENSIONING

## (WITH CUSTOMARY READOUT CHART)

CONVERSION

| mm | inch | mm | inch |
|---|---|---|---|
| 0.020 | 0.0008 | 29.39 | 1.157 |
| 0.25 | 0.010 | 40.45 | 1.593 |
| 0.5 | 0.02 | 47.55 | 1.872 |
| 0.50 | 0.020 | 50.0 | 1.97 |
| 2.0 | 0.08 | 50.00 | 1.969 |
| 7.0 | 0.28 | 57.150 | 2.2500 |
| 8.20 | 0.323 | 100.0 | 3.94 |
| 11.1 | 0.44 | 120.0 | 4.72 |
| 16.45 | 0.648 | | |




THIRD ANGLE PROJECTION

UNLESS OTHERWISE SPECIFIED:
±1° TOL ON ANGULAR DIM.
FINISH ALL OVER

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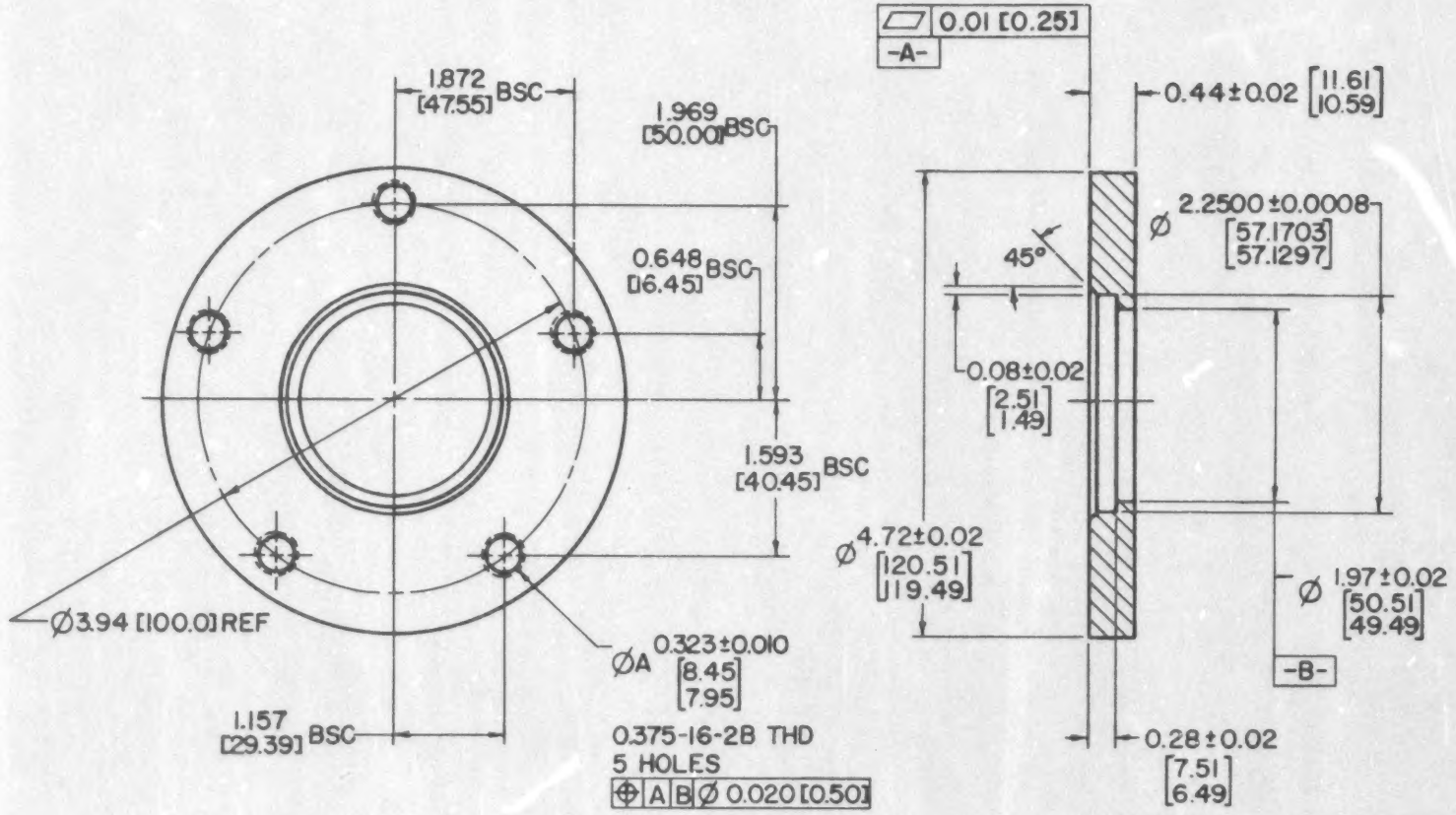
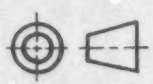
# DUAL DIMENSIONING




DIM. IN [ ] ARE MILLIMETRES

UNLESS OTHERWISE SPECIFIED:
± 1° TOL ON ANGULAR DIM.
FINISH ALL OVER

THIRD ANGLE PROJECTION



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# ROUND-OFF RULES

| TOTAL TOLERANCE IN INCHES | | MILLIMETRE CONVERSION ROUNDED TO |
|---|---|---|
| AT LEAST | LESS THAN | |
| 0.00001 | 0.0001 | 5 DECIMAL PLACES |
| 0.0001 | 0.001 | 4 DECIMAL PLACES |
| 0.001 | 0.01 | 3 DECIMAL PLACES |
| 0.01 | 0.1 | 2 DECIMAL PLACES |
| 0.1 | 1.0 | 1 DECIMAL PLACE |

| TOTAL TOLERANCE IN MILLIMETRES | | INCH CONVERSION ROUNDED TO |
|---|---|---|
| 0.005 | 0.05 | 5 DECIMAL PLACES |
| 0.05 | 0.5 | 4 DECIMAL PLACES |
| 0.5 | 5.0 | 3 DECIMAL PLACES |
| 5.0 AND OVER | | 2 DECIMAL PLACES |

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# Fractions of an inch to millimetres

| in | | mm | in | | mm | in | | mm | in | | mm |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/64 | 0.016 | 0.397 | 17/64 | 0.266 | 6.747 | 33/64 | 0.516 | 13.097 | 49/64 | 0.766 | 19.447 |
| 1/32 | 0.031 | 0.794 | 9/32 | 0.281 | 7.144 | 17/32 | 0.531 | 13.494 | 25/32 | 0.781 | 19.844 |
| 3/64 | 0.047 | 1.191 | 19/64 | 0.297 | 7.541 | 35/64 | 0.547 | 13.891 | 51/64 | 0.797 | 20.241 |
| 1/16 | 0.062 | 1.588 | 5/16 | 0.312 | 7.938 | 9/16 | 0.562 | 14.288 | 13/16 | 0.812 | 20.638 |
| 5/64 | 0.078 | 1.984 | 21/64 | 0.328 | 8.334 | 37/64 | 0.578 | 14.684 | 53/64 | 0.828 | 21.034 |
| 3/32 | 0.094 | 2.381 | 11/32 | 0.344 | 8.731 | 19/32 | 0.594 | 15.081 | 27/32 | 0.844 | 21.431 |
| 7/64 | 0.109 | 2.778 | 23/64 | 0.359 | 9.128 | 39/64 | 0.609 | 15.478 | 55/64 | 0.859 | 21.828 |
| 1/8 | 0.125 | 3.175 | 3/8 | 0.375 | 9.525 | 5/8 | 0.625 | 15.875 | 7/8 | 0.875 | 22.225 |
| 9/64 | 0.141 | 3.572 | 25/64 | 0.391 | 9.922 | 41/64 | 0.641 | 16.272 | 57/64 | 0.891 | 22.622 |
| 5/32 | 0.156 | 3.969 | 13/32 | 0.406 | 10.319 | 21/32 | 0.656 | 16.669 | 29/32 | 0.906 | 23.019 |
| 11/64 | 0.172 | 4.366 | 27/64 | 0.422 | 10.716 | 43/64 | 0.672 | 17.066 | 59/64 | 0.922 | 23.416 |
| 3/16 | 0.188 | 4.762 | 7/16 | 0.438 | 11.112 | 11/16 | 0.688 | 17.462 | 15/16 | 0.938 | 23.812 |
| 13/64 | 0.203 | 5.159 | 29/64 | 0.453 | 11.509 | 45/64 | 0.703 | 17.859 | 61/64 | 0.953 | 24.209 |
| 7/32 | 0.219 | 5.556 | 15/32 | 0.469 | 11.906 | 23/32 | 0.719 | 18.256 | 31/32 | 0.969 | 24.606 |
| 15/64 | 0.234 | 5.953 | 31/64 | 0.484 | 12.303 | 47/64 | 0.734 | 18.653 | 63/64 | 0.984 | 25.003 |
| 1/4 | 0.250 | 6.350 | 1/2 | 0.500 | 12.700 | 3/4 | 0.750 | 19.050 | 1 | 1.000 | 25.400 |



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# Inches to millimetres

| in | mm | in | mm | in | mm | in | mm |
|---|---|---|---|---|---|---|---|
| 1 | 25.4 | 26 | 660.4 | 51 | 1295.4 | 76 | 1930.4 |
| 2 | 50.8 | 27 | 685.8 | 52 | 1320.8 | 77 | 1955.8 |
| 3 | 76.2 | 28 | 711.2 | 53 | 1346.2 | 78 | 1981.2 |
| 4 | 101.6 | 29 | 736.6 | 54 | 1371.6 | 79 | 2006.6 |
| 5 | 127.0 | 30 | 762.0 | 55 | 1397.0 | 80 | 2032.0 |
| 6 | 152.4 | 31 | 787.4 | 56 | 1422.4 | 81 | 2057.4 |
| 7 | 177.8 | 32 | 812.8 | 57 | 1447.8 | 82 | 2082.8 |
| 8 | 203.2 | 33 | 838.2 | 58 | 1473.2 | 83 | 2108.2 |
| 9 | 228.6 | 34 | 863.6 | 59 | 1498.6 | 84 | 2133.6 |
| 10 | 254.0 | 35 | 889.0 | 60 | 1524.0 | 85 | 2159.0 |
| 11 | 279.4 | 36 | 914.4 | 61 | 1549.4 | 86 | 2184.4 |
| 12 | 304.8 | 37 | 939.8 | 62 | 1574.8 | 87 | 2209.8 |
| 13 | 330.2 | 38 | 965.2 | 63 | 1600.2 | 88 | 2235.2 |
| 14 | 355.6 | 39 | 990.6 | 64 | 1625.6 | 89 | 2260.6 |
| 15 | 381.0 | 40 | 1016.0 | 65 | 1651.0 | 90 | 2286.0 |
| 16 | 406.4 | 41 | 1041.4 | 66 | 1676.4 | 91 | 2311.4 |
| 17 | 431.8 | 42 | 1066.8 | 67 | 1701.8 | 92 | 2336.8 |
| 18 | 457.2 | 43 | 1092.2 | 68 | 1727.2 | 93 | 2362.2 |
| 19 | 482.6 | 44 | 1117.6 | 69 | 1752.6 | 94 | 2387.6 |
| 20 | 508.0 | 45 | 1143.0 | 70 | 1778.0 | 95 | 2413.0 |
| 21 | 533.4 | 46 | 1168.4 | 71 | 1803.4 | 96 | 2438.4 |
| 22 | 558.8 | 47 | 1193.8 | 72 | 1828.8 | 97 | 2463.8 |
| 23 | 584.2 | 48 | 1219.2 | 73 | 1854.2 | 98 | 2489.2 |
| 24 | 609.6 | 49 | 1244.6 | 74 | 1879.6 | 99 | 2514.6 |
| 25 | 635.0 | 50 | 1270.0 | 75 | 1905.0 | 100 | 2540.0 |

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# ABBREVIATIONS

## (SOME FORMER ABBREVIATIONS ARE NOW SYMBOLS)

| | |
|---|---|
| Across flats | ACR FLT |
| Centers | CTR |
| Center line | CL |
| Centimetre | cm |
| Chamfer | CHAM |
| Counterbore | CBORE |
| Countersink | CSK |
| Countersunk head | CSK H |
| Diameter(before the dimension) | Ø |
| Diameter(in a note) | DIA |
| Drawing | DWG |
| Figure | FIG |
| Hexagon | HEX |
| Hexagonal head | HEX HD |
| Inside diameter | ID |
| Left hand | LH |
| Material | MATL |
| Metre | m |
| Millimetre | mm |
| Number | NO |
| Outside diameter | OD |
| Pitch diameter | PD |
| Radius(before the dimension) | R |
| Right hand | RH |
| Round | RD |
| Square(before the dimension) | □ |
| Square(in a note) | SQ |
| Thread | THD |



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## ORTHOGRAPHIC PROJECTION COMPARISON

First-angle projection isn't a metric method of drawing but a consequence of international standards. One of the main reasons metrication is taking place in the United States is to facilitate communication on the international level. Since many European countries draw in first-angle projection, it is important for the students to at least get a basic exposure to first-angle projection. The difference between first and third angle projection is that in first-angle the object as viewed is projected onto the drawing surface, while in third-angle the object is drawn as viewed. A careful study of this transparency will clarify this idea. A metric drawing should specify first or third-angle projection, as indicated on the transparency.

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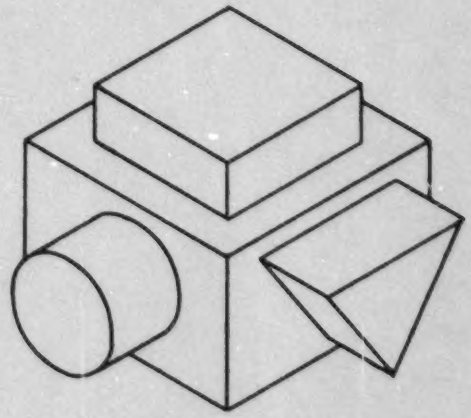
# ORTHOGRAPHIC PROJECTION COMPARISON





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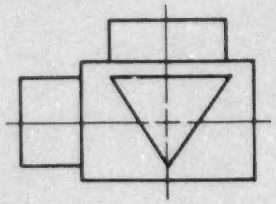
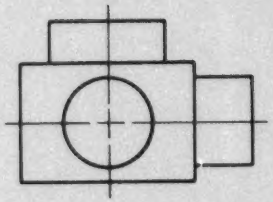
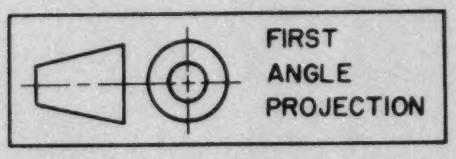
FRONT ELEVATION

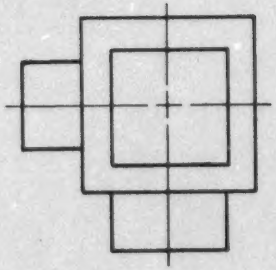


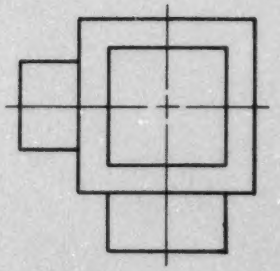


END VIEW

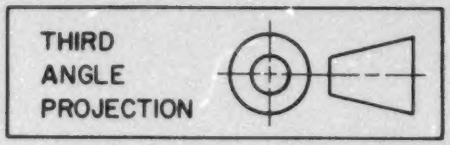


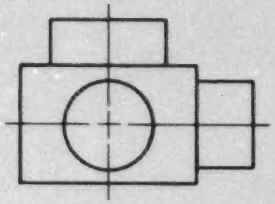

TOP (PLAN) VIEW



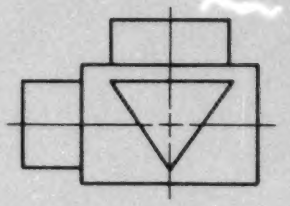


TOP (PLAN)
VIEW



END
VIEW



FRONT
ELEVATION

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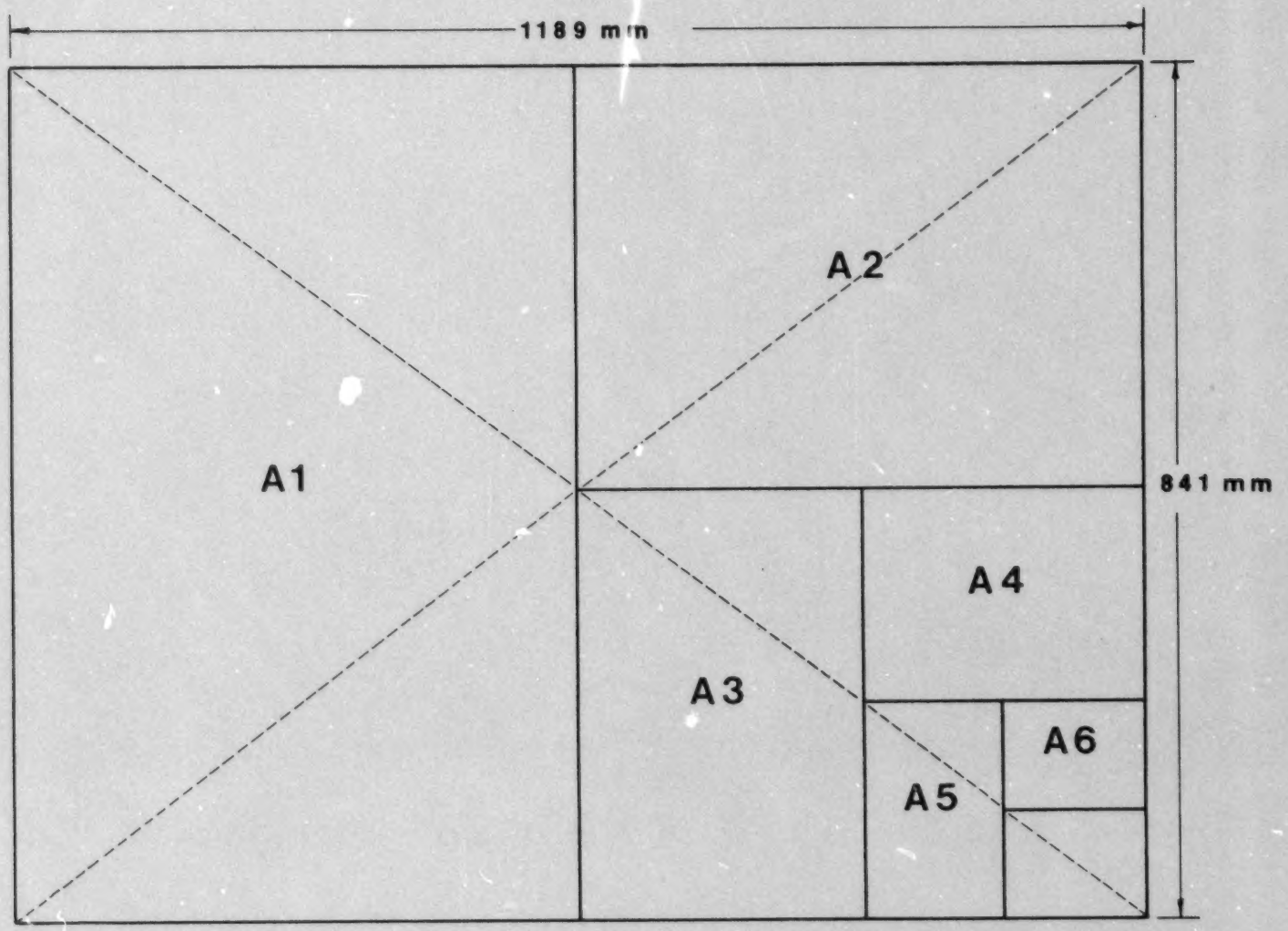
# ISO - A SIZE PAPER




1189 mm x 841 mm = 1 SQUARE METRE

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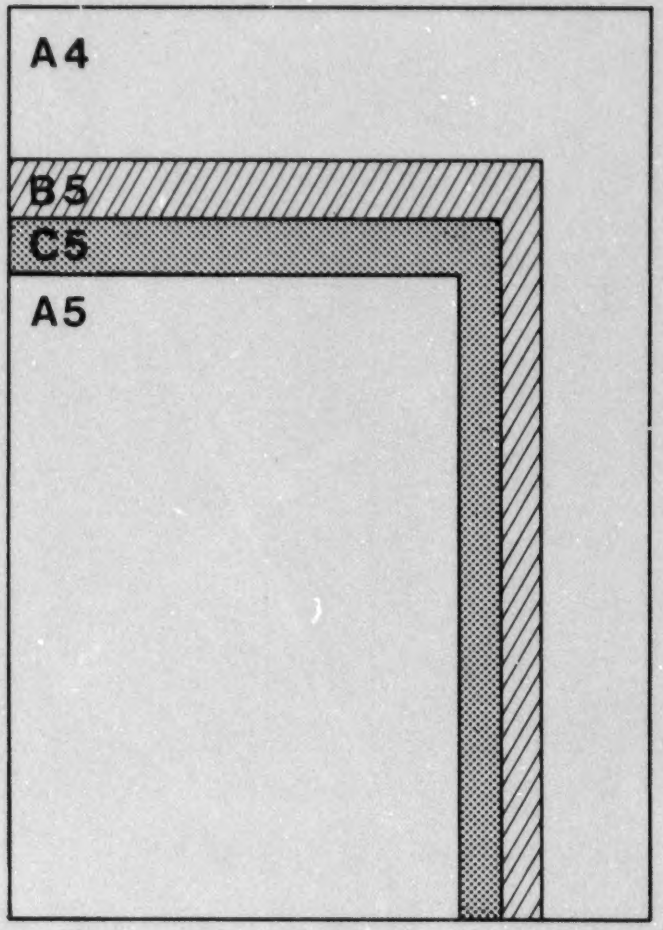
# RELATIONSHIP BETWEEN A, B, AND C SIZE PAPER



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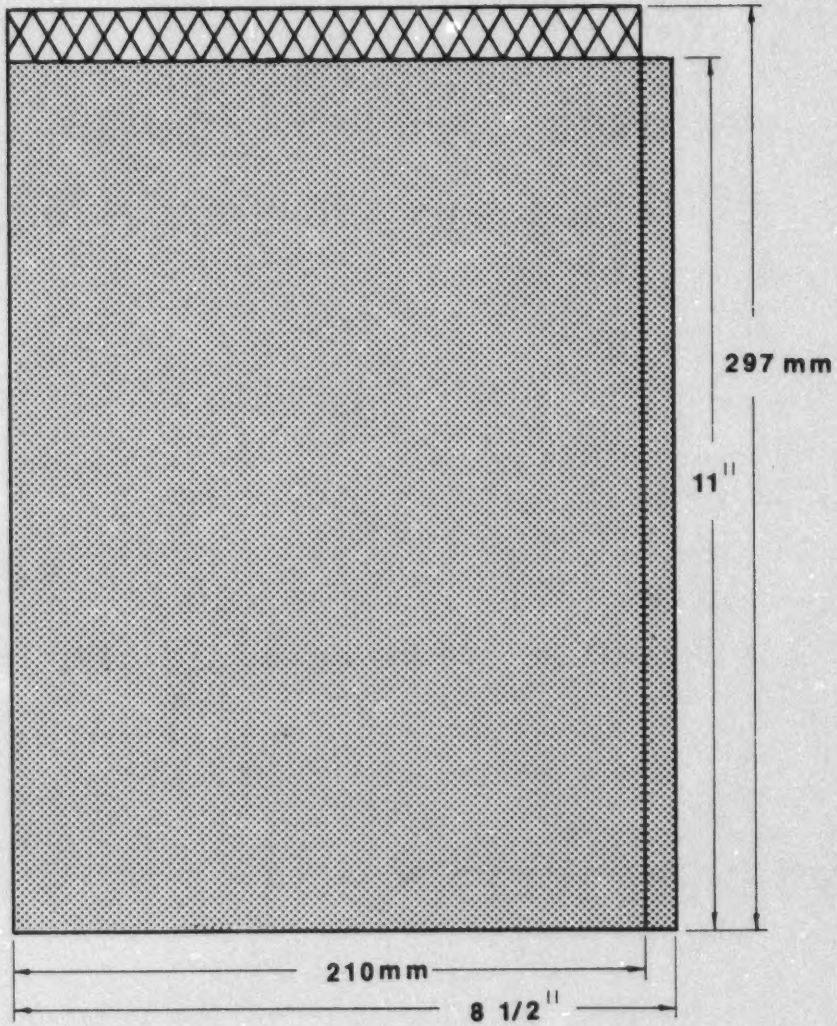


# COMPARING $8\frac{1}{2} \times 11$ TO ISO A4 SIZE PAPER

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# STOCK SIZES - FOR A SERIES PAPER

## Sizes for Normal Trims

| ISO - size | METRIC - millimetres | CUSTOMARY - inches |
|---|---|---|
| RAO | 860 x 1220 | 33.86 x 48.03 |
| RA1 | 610 x 860 | 24.02 x 33.86 |
| RA2 | 430 x 610 | 16.93 x 24.02 |

## Sizes for Bleed Work or Extra Trims

| ISO - size | METRIC - millimetres | CUSTOMARY - inches |
|---|---|---|
| SRAO | 900 x 1280 | 35.43 x 50.39 |
| SRA1 | 640 x 900 | 25.20 x 35.43 |
| SRA2 | 450 x 640 | 17.72 x 25.20 |

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# COMPARISON CHART - A SIZE PAPER

| ISO-sizes | METRIC-millimetres | CUSTOMARY-Inches |
|---|---|---|
| 2A | 1189 x 1682 | 46.81 x 66.22 |
| A0 | 841 x 1189 | 33.11 x 46.81 |
| A1 | 594 x 841 | 23.39 x 33.11 |
| A2 | 420 x 594 | 16.54 x 23.39 |
| A3 | 297 x 420 | 11.69 x 16.54 |
| A4 | 210 x 297 | 8.27 x 11.69 |
| A5 | 148 x 210 | 5.83 x 8.27 |
| A6 | 105 x 148 | 4.13 x 5.83 |
| A7 | 74 x 105 | 2.91 x 4.13 |
| A8 | 52 x 74 | 2.05 x 2.91 |
| A9 | 37 x 52 | 1.46 x 2.05 |
| A10 | 26 x 37 | 1.02 x 1.46 |



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# COMPARISON CHART - B SIZE PAPER

| ISO-sizes | METRIC-millimetres | CUSTOMARY-inches |
|---|---|---|
| **B0** | **1000 x 1414** | **39.37 x 55.67** |
| B1 | 707 x 1000 | 27.83 x 39.37 |
| **B2** | **500 x 707** | **19.68 x 27.83** |
| B3 | 353 x 500 | 13.90 x 19.68 |
| **B4** | **250 x 353** | **9.84 x 13.90** |
| B5 | 176 x 250 | 6.93 x 9.84 |
| **B6** | **125 x 176** | **4.92 x 6.93** |
| B7 | 88 x 125 | 3.46 x 4.92 |
| **B8** | **62 x 88** | **2.44 x 3.46** |
| B9 | 44 x 62 | 1.73 x 2.44 |
| **B10** | **31 x 44** | **1.22 x 1.73** |



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# R20 SERIES OF PAPER WEIGHTS AND EQUIVALENT WEIGHTS

| *'R' series* | *Bond 17 x 22 432 x 559 mm* | *Cover 20 x 26 508 x 660 mm* | *Index 25½ x 30½ 648 x 775 mm* | *Newsprint 24 x 36 610 x 914 mm* | *Book 25 x 38 635 x 965 mm* |
|---|---|---|---|---|---|
| *g/m²* | *lb/ream* | *lb/ream* | *lb/ream* | *lb/ream* | *lb/ream* |
| 20.0 | 5.32 | 7.39 | 11.00 | 12.29 | 13.51 |
| 22.4 | 5.95 | 8.28 | 12.39 | 13.77 | 15.13 |
| 25.0 | 6.65 | 9.24 | 13.83 | 15.36 | 16.89 |
| 28.0 | 7.44 | 10.35 | 15.49 | 17.21 | 18.92 |
| 31.5 | 8.37 | 11.65 | 17.43 | 19.36 | 21.28 |
| 45.0 | 11.97 | 16.64 | 24.89 | 27.66 | 30.40 |
| 50.0 | 13.30 | 18.49 | 27.66 | 30.73 | 33.78 |
| 56.0 | 14.89 | 20.71 | 30.98 | 34.42 | 37.84 |
| 63.0 | 16.75 | 23.30 | 34.85 | 38.72 | 42.57 |
| 71.0 | 18.88 | 26.26 | 39.28 | 43.63 | 47.97 |
| 85.0 | 22.61 | 31.45 | 46.90 | 52.27 | 57.46 |
| 100.0 | 26.60 | 36.98 | 55.32 | 61.46 | 67.57 |
| 112.0 | 29.79 | 41.42 | 61.96 | 68.83 | 75.68 |
| 140.0 | 37.24 | 51.78 | 77.45 | 86.04 | 94.60 |
| 180.0 | 47.88 | 66.57 | 99.58 | 110.62 | 121.63 |
| 200.0 | 53.20 | 73.97 | 110.64 | 122.91 | 135.14 |
| 250.0 | 66.50 | 92.46 | 138.30 | 153.64 | 168.93 |
| 400.0 | 106.41 | 147.95 | 221.29 | 245.83 | 270.29 |

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# PRINTER'S UNITS
# CUSTOMARY & METRIC EQUIVALENTS

| PRINTER'S | | CUSTOMARY—INCHES | | METRIC—millimetres |
|---|---|---|---|---|
| Picas | Points | Approximate Fraction | Decimal | |
| | 1 | 1/64 | .014 | .35 |
| | 2 | 1/32 | .028 | .70 |
| | 3 | 3/64 | .042 | 1.05 |
| | 4 | 7/128 | .055 | 1.40 |
| | 5 | 1/16 | .069 | 1.75 |
| | 6 | 5/64 | .083 | 2.10 |
| | 7 | 3/32 | .097 | 2.45 |
| | 8 | 7/64 | .111 | 2.80 |
| | 9 | 1/8 | .125 | 3.15 |
| | 10 | 9/64 | .138 | 3.50 |
| 1 | 12 | 21/128 | .166 | 4.20 |
| | 14 | 25/128 | .194 | 4.90 |
| | 18 | 1/4 | .249 | 6.30 |
| 2 | 24 | 21/64 | .332 | 8.40 |
| | 30 | 53/128 | .414 | 10.50 |
| 3 | 36 | 1/2 | .498 | 12.60 |
| | 42 | 37/64 | .581 | 14.70 |
| 4 | 48 | 85/128 | .664 | 16.80 |
| 5 | 60 | 53/64 | .828 | 21.00 |
| 6 | 72 | 1 | .996 | 25.20 |

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# METRIC UNITS
# PRINTER'S & CUSTOMARY EQUIVALENTS

| METRIC-millimetres | PRINTER'S | | CUSTOMARY-Inches |
|---|---|---|---|
| | Points | Approximate Picas + Points | |
| 1 | 2.86 | | .039 |
| 2 | 5.71 | | .079 |
| 3 | 8.57 | | .118 |
| 4 | 11.43 | | .157 |
| 5 | 14.29 | 1 + 2¼ | .197 |
| 6 | 17.14 | 1 + 5 | .236 |
| 7 | 20.00 | 1 + 8 | .276 |
| 8 | 22.86 | 1 + 10¾ | .315 |
| 9 | 25.71 | 2 + 1½ | .354 |
| 10 | 28.57 | 2 + 4½ | .394 |
| 15 | 42.86 | 3 + 6¾ | .591 |
| 20 | 57.14 | 4 + 9 | .787 |
| 25 | 71.43 | 5 + 11 | .984 |
| 30 | 85.71 | 7 + 1¼ | 1.181 |
| 35 | 100.00 | 8 + 3½ | 1.378 |
| 40 | 114.28 | 9 + 5¾ | 1.575 |
| 45 | 128.57 | 10 + 4 | 1.772 |
| 50 | 142.85 | 11 + 6¼ | 1.969 |
| 75 | 214.28 | 17 + 5¼ | 2.953 |
| 100 | 285.71 | 23 + 8½ | 3.937 |

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# SCREEN RULINGS

| Customary Rulings per inch | Metric Rulings per centimetre |
|---|---|
| 50 | 20 |
| 65 | 26 |
| 75 | 30 |
| 100 | 40 |
| 120 | 48 |
| 133 | 54 |
| 150 | 60 |
| 175 | 70 |
| 200 | 80 |



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